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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Balfour Deputation.

We learn from the official statement that his Majesty's Government have reached a definite decision with regard to their future relations with the Research Associations which are at present in receipt of grant aid. It will be remembered that these bodies were to receive such aid for a period of ten years, the object being to stimulate the industries during this period into the establishment of permanent co-operative research organisations.

Founded as they were during the boom period that followed the Armistice, a few years seemed ample to achieve this object. It has become increasingly evident that, as the result of prolonged industrial depression, so short a period would be quite inadequate. The Research Associations, therefore, recently formed a standing committee to consider the question. As the result of the work of this committee a petition was presented on June 29 to the Lord President of the Privy Council (the Right Hon. Earl Balfour, K.G.) urging the necessity for continued grants over a longer period on various grounds of national importance. The first of these grounds was the vital importance of industrial research to the Services and to the nation in general; the second was the fact that the benefits of such research are felt at least as much by the consumer as by the manufacturer. In addition it is a fact that the total cost of the assistance requested amounts to a figure ridiculously small in comparison with the sums expended, for instance, on sugar beet or on the Empire Marketing Board. Further, it is not always sufficiently clearly appreciated that the value of the Research Association does not end with those of its results which can be measured in terms of money. It brings into being innumerable contacts and co-operative efforts of extraordinary value, so that its very existence becomes an asset to the appropriate industry.

In his reply to the deputation, Lord Balfour stated that the Government had decided to make a further offer of grant on a pound for pound basis in respect of subscription income in excess of certain minimum figures, to be fixed in each case on the advice of the Advisory Council. Unless this minimum income was assured no grant would be payable. Above the approved figure, and up to a maximum which would be fixed in the same way, the grant would be given for a further period of five years, renewable for another five years in suitable cases.

It will, of course, be obvious that everything depends upon the way in which the Advisory Council interprets the "minimum figure," this being in fact the key to the whole position.

The Cast Iron Research Association has every reason to be proud of this result, which appears to ensure continuity, although the terms are not yet fixed in detail. Not only did the Association take a prominent part in the formation of the standing committee responsible for the petition, but in addition its president, Major-General Sir Philip Nash, K.C.M.G., took a leading part in the actual deputation, and was in fact responsible for one of the leading speeches.

General Industrial Knowledge.

A few weeks ago, in preparing a note dealing with the annual studying tour undertaken by the students of the Paris Foundry High School, we commented upon the desirability of this phase of academic activity being extended to similar British organisations. We have to thank Professor Hanson for pointing out that this is already *un fait accompli*, and no doubt each authority will have its own notion as to the most suitable means of obtaining the best results from such enterprises.

We wish it to be clearly understood, however, that a *voyage d'étude*, or studying journey, is not to be confused with vacation courses spent in industrial establishments whereat the student for a period becomes a member of its staff. The object of a studying journey as we view it, is to obtain a bird's eye view of the industry for executive membership of which the student is in process of qualification. The paramount importance of this elementary notion can be readily visualised by the foundry owner, if when interviewing an aspirant for a technical position in his works, he finds that the applicant has never heard that Stanton cast pipes centrifugally or that Ley's have the largest malleable foundry in Great Britain. These are such commonplaces to the industrialist that any person claiming close association with the foundry trade yet being unfamiliar with them immediately creates an impression that the applicant is ignorant in the extreme. We suggest that the best method of familiarising students with industrial activities and processes is the organisation of studying tours on a co-operative basis in order to cause the works visited a minimum of dislocation. This suggestion is put forward because the hospitality offered by a works to one organisation is rapidly followed by requests from others "too numerous to mention." Mr. Fox-Allin's articles when complete will, we hope, show the facilities not merely for foundry but also metallurgical study in Great Britain, and at the moment we cannot envisage that a series of co-operative studying tours embracing all of them would create an unmanageable body of individuals. The meeting of students from a large number of centres would induce chatter about local industries and so mutually augment their knowledge of that important subject not amenable to examination, "*General Industrial Knowledge.*" It cannot be too strongly stressed that students possessing this are those who make most progress in after life—this we propound from personal observation. Yet we should be the last to suggest that "Ryland's Directory" become a student's textbook, and adhere to the necessity of acquiring general industrial knowledge by systematic studying journeys spread over the period of graduation.

XUM

Does Haggling Pay.

BY "ONLOOKER."

The elimination of price competition in electrolytic copper through the action of the exporters in fixing the quotation and freezing out merchant houses has taken a good deal of interest out of buying, for wherever the consumer goes for his copper he is sure to meet with a dead level of values. Such stabilisation may have its good points, but it takes the zest out of a purchasing job, and offers in return the poor consolation that "the other man" is not getting his metal any cheaper. To a business man worth his salt that is not much satisfaction.

It is, of course, still possible from time to time to secure a parcel of electrolytic copper below the price asked by the central sales organisation, but this cannot be used as a lever to persuade members of the association to make a cut, for their hands are tied, and much as the selling agents—all men of many years' experience in the copper trade—would like to "have a go at the other fellow," that pleasure is debarred them. A certain amount of latitude is still possible in prices quoted for fine refined brands of copper, but generally speaking these are fixed at an unvarying margin below electro. Spelter and tin are, of course, still open markets, where it is possible to do a bit of beating about the bush if a buyer feels so disposed, but these metals are quoted daily on the London Metal Exchange and are thus "labelled" by their official prices, and wide variations in quotations by different traders made extremely unlikely.

There remains for consideration the scrap market, which may, without exaggeration, be dubbed the haggler's happy hunting ground, since official prices simply do not exist, and there are a thousand and one points about the average parcel which may be seized upon as a pretext for depreciating its value. The horse dealer and the scrap buyer have this much in common, that each is chiefly concerned with pointing out the faults in his prospective purchase; but at the same time it is well to remember that a seller must be allowed some voice in the matter, and that he may, if he wish, withdraw his horse or his scrap altogether.

Bluff is as much a part of the game of buying scrap as it is of poker, and just as in the famous card game your opponent may call your bluff with results disastrous to yourself, so, also, too much insistence on your ability to buy equally good stuff elsewhere may lose you your parcel of scrap and enable one of your competitors to secure it. A little argument about values is, of course, all to the good, for it enables the holder to point out the virtues of his material and gives the prospective purchaser a chance to estimate his chance of securing a reduction in the price, but argument carried to the point of wrong-headedness is a mistake, and is apt to prejudice future business relationship.

Some buyers like to boast that they are "tough nuts" to crack and that they can always force down the price of any material that is offered to them, but the reputation thus gained is hardly an enviable one, and certainly does not stand them in good stead in everyday business transactions. Scrap metal merchants are not the least astute of men, and it is their particular care to learn as much as possible not only about their customers' requirements but also about the customers themselves. Once let a buyer earn a reputation for everlasting haggling and his suppliers will always offer him stuff at a price which will bear pruning. To some temperaments a deal is only a deal if a reduction is obtained in the price first offered, and such people go through life under the impression that they, and only they, invariably secure their requirements under the market price.

This question of price reduction under pressure, of course, cuts both ways, and if it is bad policy for a buyer to acquire a reputation for always haggling, it is equally disadvantageous for purchasers to earmark a firm of suppliers as one which will invariably reduce if pressed hard enough. The impression thus gained imparts a feeling of distrust, for it becomes evident that the first quotation made is by way of being a "try on," and that to accept it would be a mistake.

The retail shop which adopts the practice of marking all goods in plain figures at their lowest cash price can usually be seen thronged with customers, and in the same way the metal merchant who offers a good line at the lowest price he is prepared to accept from firms of proved financial stability, should never go short of orders. A seller is quite entitled to grade his prices in accordance with the standing of the house to which he is offering his stuff, for in some directions he will have to wait longer for his money, and there are also those, who though they may not argue about price, make a point of picking faults with the parcel after delivery, and claiming an allowance to cover the supposed defect.

Offer and counter-offer, bid and counter-bid are of the stuff that commerce is made from, but let the combat be short, sharp and decisive, for life is too short to be frittered away in foolish haggling. Buyer and seller alike should know their own minds and also the value of the merchandise under discussion. On that presumption haggling is merely a futile diversion intended for babes and beginners!

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Standardisation of Foundry Facings.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I was very interested to read the report in THE FOUNDRY TRADE JOURNAL of the discussion at the annual meeting of the Newcastle Branch, part of which had reference to the question of foundry facings.

This is a subject which has been the centre of investigation and research by the firm of which I have the honour to be the head for a number of years past, and I was hoping that as a result of our tests and experiments, which have been published from time to time, the subject might by this time have been approached upon a much broader basis than was formerly the case. But I confess to a feeling of grave disappointment on reading the discussion, because it gave the impression that both the iron-foundry industry and the blacking industry were still governed by rule of thumb. This is emphatically not the case to-day, not only in the foundries of the country, but also in the blacking industry, though, of course, there are still members of both industries who lag far behind, and will not rid themselves of old-fashioned ideas.

May I venture to suggest that my firm may be counted amongst those whose earnest desire it is to produce the best article manufactured on a scientific basis.

The provision of facings should nowadays be governed by co-operation between the practical man, the foundry laboratory, and the laboratory of the manufacturers, and wherever possible this is our aim. We have now in active operation three laboratories, and I can confidently assert that investigations are always carried out with a view to the continued improvement and standardisation of all our manufactures. Moreover we always welcome hints and data from our customers, who have the benefit of practical application day by day.—Yours, etc.,

H. WINTERTON,
Chairman and Managing Director of
Wm. Cumming & Company, Limited.
Kelvinvale Mills, Maryhill, Glasgow, N.W.
July 4, 1928.

Recasting Church Bells.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In view of the fact that ancient church bells have a distinct and well-recognised sentimental value, and that their recasting when damaged is distasteful to all who regard sympathetically all those things which belong to a bygone age, the statement recently made in a well-known periodical to the effect that the repair of cracked church bells of historic interest is a matter of considerable difficulty, cannot be allowed to go unchallenged, because it tends to induce the wholly false impression that nothing remains to be done other than the "scrapping" of the unit.

As one having considerable experience of the reconstruction of bells of both large and small dimensions, may I say that, owing to the employment of modern scientific methods, their restoration—irrespective of age, size, composition, or condition—is a comparatively simple matter. Indeed, the firm with which I am associated has already completely restored several valuable and historic bells dating from the thirteenth century, and is at the moment engaged on the reparation of a peculiarly interesting bell, the seventh of a peal of twelve, founded in the year 1607, and, as the whole question is one of very considerable interest I should welcome its inspection by a representative of THE FOUNDRY TRADE JOURNAL, or, indeed, by any one possessing special knowledge of bells or bell-foundry.

Our experience is that, properly handled, any carillon unit can be readily restored to full and true tone, even when extensively cracked or damaged, or constructed of metals not now in common use.—Yours faithfully,

C. W. BRETT,
Managing Director of Barimar, Ltd., Scientific Welding Engineers.
14-18, Lamb's Conduit St., Theobald's Rd.,
London, W.C.1.
July 6, 1928.

Random Shots.

I have been glancing at the papers, lately come to hand, that were presented at this year's Philadelphia Convention of the American Foundrymen's Association. Since there were no fewer than thirty of these I could hardly fail to be struck by the contrast between this and Leicester, where our own modest collection only numbered five. The thirty papers were of great variety, and not all of equal merit, and they gave evidence that the founding world in America gives relatively much more time and attention to steel and non-ferrous casting than is the case here.

* * *

A further point struck me, although hardly for the first time, since it relates to a matter of common American practice. The printed proceedings do not content themselves with the papers and the discussions thereon. They also include committee reports which, being due to come up for discussion, are pre-printed and circulated like the papers, and they complete the good work by giving the discussions as well. There are, of course, points on both sides. But there are times and circumstances when the American practice might be decidedly useful.

* * *

As a case in point, the I.B.F. Test-bar Committee did a great deal of strenuous and important work, and duly reported it in the proper quarter. But how much of that work has really seen the light of day—or rather, how much of it would have done so but for the B.E.S.A. specification? It is largely through the medium of the use that is made of it that the bulk of our special committee work achieves publicity, and the American method must at least do something to fill the gap.

MARKSMAN.

Foundry Query.

Blow Lamps for Skin Drying.

The "Gem" lamp, made by Messrs. Woodward Brothers and Copelin, Limited, Oakhill Road, Sutton, Surrey, is a suitable lamp for the purpose.—[ED. F.T.J.]

A Session on Sand Problems.*

MR. FAULKNER, in introducing the subject, remarked that M. Lamoureux's Paper was merely a thought, but a very interesting thought. It was the result of years of experience of handling sand, rather than conclusions derived from a series of systematic tests. The author was a practical man, and probably had not had at his disposal any research organisation. He would just remind them, by going through the first two or three pages, of his ideas, which were perhaps of a somewhat ingenious character.

MR. FAULKNER proceeded to read extracts from the Paper.

American Moulding Practice.

The PRESIDENT said there had been a considerable amount of real research done on moulding sand in the last few years. They had awarded a diploma at that Association to one of their members for a Paper presented on moulding sand, in which the author went to a very considerable amount of trouble in discussing the various methods of testing sand, and the various tests which could be applied to permeability for general purposes—simple tests which could be used in the foundry. To some extent the Paper seemed a little on the elementary side, as compared with some of the Papers which had been presented to branches, and also the research reports which had been issued in connection with the moulding sands of Great Britain. Though he had not carefully studied the Paper, it appeared to him to throw up a line of thought which was somewhat original to him, though it might not be so to the general body of members. On page 5 of the preprint the author stated that when the castings were dry-sand moulded the moulds were relatively sound, but in green-sand moulding scabs or blisters were frequently found. He inferred that the author was trying to prove by that his preliminary statement with regard to the position of the grains of sand due to treatment of ramming; but there were many other reasons why a dry-sand casting should be sounder on the average than a casting produced by green-sand moulding, which reasons needed no elaboration from him, because most of them knew the safeguards produced by drying. In the same paragraph the author stated: "In America, for most cylindrical castings, instead of a bevelled board, it was customary to use a portion of the pattern fixed to the spindle arm, against which the pattern sand is rammed." He had had the pleasure of visiting a number of American foundries, but in none of them did he see any loam work being split up, so that he could not answer that. But it did appear to him that it might not be due to the fact that the method used in America of ramming against the portion of the pattern fixed to the spindle arm was the better one, but it might be due to the fact that the American moulding sands are very very different in constitution from the English sands. Very few American sands had any natural bond at all. The bond had to be introduced. Many of them on the recent trip were surprised at the apparent creeping, and found that the Americans did not know much about the moulding sand they used. That was even overcome by drawing across the mould a very thick coat of blacking or facing to produce the necessary smooth skin. He did not see any loam work being split up; but it may be that system was adopted in America because their sands, being of a very dry nature, would not hold up in the plastic state. On page 9 of the parchment, after referring to the runners with downrights, the author said that a cylindrical section was best, because the release of the gases was effected by channels. Then he referred to the fact that runners of prismatic form frequently showed scabs caused by the passage of the metal. The runners he described were what they would usually call oblong, or square runners or downrights. To him that passage suggested a new line of thought. In their own works, on their bigger castings, he would say 75 per cent. of the downrights were square. They had had many troubles, but it had never occurred to him that any trouble could be caused by the use of a square downright as against a round downright. If any member could make any contribution to the discussion on that point it would be of general interest to the Institute. Although he did not want to say that the Paper was elementary, yet it opened several very interesting lines for discussion. Sand was an important problem, because many of their best seams were being worked out, and they were being forced to use rather inferior sand.

Features in Running Castings.

MR. COOPER (Darlington) said the question of sand interested him very much, and that Paper in particular, for the reason that he had the pleasure of knowing M. Lamoureux. Many years ago he was connected with a number of Belgian and French people when they introduced Belgian sand into England. Many failures which were caused in foundries were not caused on account of the sand, but by the methods of preparing the sand. In the majority of foundries in England, in comparison with the foundries on the Continent, one of the first things to be done was to put in a sand suitable for mixing, because they all knew that sand should not be ground if one wanted to make it in such a form that the gases could escape in an easy manner. For that reason, M. Lamoureux evolved a mill of his own which had corrugated rollers. They all knew the aerator for splitting the sand after mixing in the mill was also evolved therefrom. When M. Lamoureux brought Belgian sand to England he saw it put in a mill containing rollers weighing 5 or 6 cwt., together with a quantity of old sand, and by the time it was removed it was caked in lumps. When it came to be rammed up in the mould it was impossible for the moulder, however skilful he was, to utilise it with success. Although the Paper was elementary, there was no doubt that M. Lamoureux got down, as he said himself, to the elementary principles of all things, because, in foundry work, it was the elementary principles which gave the most trouble. Very often they overlooked them. If they would just revive a little the knowledge they acquired as boys they would escape much trouble. As to the question of the square runners, the point suggested that square runners were better. Round ones also were better for no apparent reason; but what one wanted in filling the moulds was to get the metal in as easily as possible to prevent any surging.

M. IVAN LAMOUREUX.

M. Lamoureux is the chairman of one of the sections of the Belgian Foundrymen's Association, and was the author of the Paper on the "Cohesibility of Rammed Sand." He is the principal supplier of foundry plant in Belgium.

Sand Face Influenced by Pattern Withdrawal.

MR. E. LONGDEN pointed out that the author was evidently dealing with green sand the whole of the time; but there was a great mass of castings which were made in dry sand and loam. He was rather surprised to learn that sand would conveniently arrange its flat surfaces, even when rammed on the flat. He was of opinion that it was very unlikely that the grains would so arrange themselves on the flat face of the pattern. It seemed to him that the action really was the forcing of the smaller grains and clayey matter to the surface. Also, in his opinion, the vertical sides of the mould were rough because the sand was rammed against the wooden pattern and the wood grain stuck to the sand and prevented its clean withdrawal. That dragging action was reproduced on the casting, because the flat surface received the greater portion and the sides a minimum of the blacking used for facing. Unless one rubbed the side of the mould one did not get a smooth surface. There was also the roughening action of the metal rising, and the sides were subjected to glare of the metal, whilst the flat surface was covered quickly. The rising metal caused the sand grains to expand and re-orientate. That, to some extent, was the reason why the sides were rough.

With regard to round or square runners, in his opinion, while gas had a very bad effect on scabbing on the surface of the mould, he considered it was partly due to the expansion of the mould or sand face owing to overheating and making an arch. Sand grains held together better as an arch than in a flat surface. That many moulds scabbed was due not to actual gas evolution, but they scabbed because the surface expanded more than the interior. As to Belgian sand generally, he thought they had sands in Britain which were quite as good as the Belgian sands. It was a matter of treatment of the sand rather than the composition of the available sands in Belgium.

Substantiation by Micro Photos Desired.

MR. GOODWIN did not think the author had quite presented his case in a way which was quite acceptable. He would like to ask him how he had arrived, and by what method, at his conclusions with regard to the sectional parts of the mould without photographing it under the microscope? Could the author substantiate them with any actual photographs or any actual data? With regard to the vertical and flat surfaces, Mr. Longden had thrown some light on the matter on the same lines that he would have desired to adopt, but he would go a little further and say that if the pattern was made with the grain of wood horizontally the roughness of the surface was much more obvious than if the pattern was made with the timber in a vertical position. There was a definite slipping effect on the surface and the sides of the mould, which certainly made it much smoother than even a flat surface. If one rammed the sand on the open grain timber one had a distinct impression of that grain of the timber, though the light might not show it up. The vertical lights striking the vertical planes of the mould rather showed up a rougher surface than appeared on the bottom. If one got down on one's knees and examined it as a horizontal surface to the eye, one found that that surface was much smoother than one anticipated, owing to the sleeking effect of the pattern. He would not like it to be thought that the supply of good sand in Britain was running out. In England there was as good sand as ever there was, and large fields of good sand were constantly being found, especially in the older districts, where the sand practicable for moulding was renowned.

As to the point with regard to square or round runners, he was a firm believer in the round

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* A discussion on the Cohesibility of Rammed Sand, a Paper written by Ivan Lamoureux (President of the Liége-Limbourg-Luxemburg Section of the Association Technique de Fonderie of Belgium) for the Leicester Conference of the Institute of British Foundrymen.

runner, for the reason that one had to do away with the corner of the square runner, which, after all, had a tendency to increase the dross in going through to the casting. It helped to make dirt and eventually caused a small scab. The second reason was that it was possible with a round runner, in withdrawing it, even though it be a tapering one, to give it a twist before one withdrew it, thus bestowing a very fine surface on the runner. These details were elementary details, but they all contributed towards making a successful casting. They had to thank the author for giving a new thought with regard to sand moulding; but, at the same time, he was a little bit disappointed that he had not backed up his ideas with some definite data.

Suppliers Should Grade Sand.

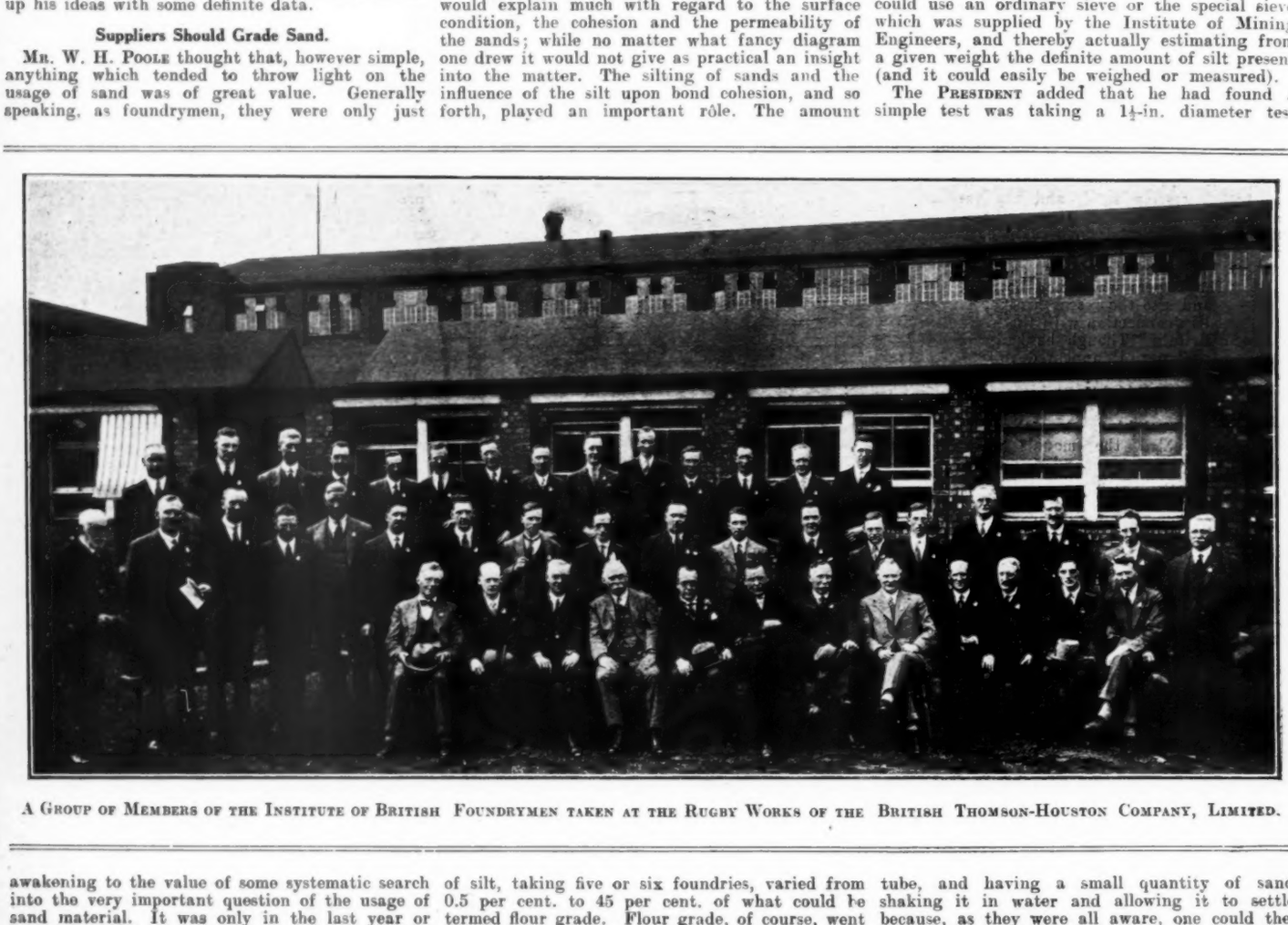
MR. W. H. POOLE thought that, however simple, anything which tended to throw light on the usage of sand was of great value. Generally speaking, as foundrymen, they were only just possible to obtain good and very reliable photographs of the green sand conditions in moulding sands. It brought up a matter which every foundryman could himself study in a very simple way. It was the essence of simplicity, and that could not be over-stressed. Technical men were rather open to having bricks thrown at them by trying to be too academic, and not getting right down on to the floor. How many foundrymen took a systematic test daily, or two or three times a week, on such a simple thing as the amount of silt in the sand? One of the most important and simplest things to his mind was the examination of the condition of the foundry floor sand. Photographs, instead of diagrammatic drawings, would explain much with regard to the surface condition, the cohesion and the permeability of the sands; while no matter what fancy diagram one drew it would not give as practical an insight into the matter. The silting of sands and the influence of the silt upon bond cohesion, and so forth, played an important rôle. The amount to pay more attention to this very important aspect of his industry than had been the case in the past.

Simple Testing Methods.

The PRESIDENT, in thanking Mr. Poole for his contribution, was not quite clear whether what he called the simple silting test had reference to the method adopted by Mr. Fletcher, of just taking a glass-stoppered bottle and shaking it, and noting the rate of settlement.

MR. POOLE replied that that was one method, and the other was to use the elutriation plant referred to in Mr. Boswell's book and keep standardised the exact figure of silt in the sand. One could use an ordinary sieve or the special sieve which was supplied by the Institute of Mining Engineers, and thereby actually estimating from a given weight the definite amount of silt present (and it could easily be weighed or measured).

The PRESIDENT added that he had found a simple test was taking a 1½-in. diameter test



A GROUP OF MEMBERS OF THE INSTITUTE OF BRITISH FOUNDRYMEN TAKEN AT THE RUGBY WORKS OF THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED.

awakening to the value of some systematic search into the very important question of the usage of sand material. It was only in the last year or two that foundrymen had given sufficient thought to the utilisation of sand to the best possible advantage for themselves, and, incidentally, to the quality of the castings which they produced. It might be wise, in the case of English sands, that suppliers should pay more attention to grading the sand at the pit before supplying to the foundrymen. In going round a number of pits in the country some four or five years ago one was rather astounded that it seemed to be merely a question of taking from the pits anything which happened to come along and sending it to the foundrymen, whilst hoping for the best. It was interesting to note, however, that some suppliers of sands were taking a very keen interest in the grading of sands. He was of opinion that there were sufficient sands of fine quality in Britain to compete with anything which might be obtained from the Continent. The Belgians were particularly fortunate, no doubt, in steel moulding sands, in that they had natural deposits which were of very great value. The Paper was certainly very simple, and he was disappointed at the author illustrating his argument with purely diagrammatic drawings. It was quite of silt, taking five or six foundries, varied from 0.5 per cent. to 45 per cent. of what could be termed flour grade. Flour grade, of course, went through an exceedingly fine mesh. He suggested, in view of the simplicity of the Paper, that foundrymen should do that very simple silt test periodically. He would also refer them to the wonderful work which had been done by Boswell in connection with sand. There should not be a foundryman present who had not got Boswell's book on moulding sand. Boswell was a great authority on the question of sands; and in his book he gave so much information that could be turned to practical value that he, the speaker, was very surprised that the knowledge given had not been more utilised. It would have been interesting to have had more information about grain size, milling sand or milling and aerating it, with some information as to the surface conditions to be thus obtained. Personally, he took something like 40 or 50 tests a week in foundry sands. He had instituted, amongst people whom he could get sufficiently keen, a means of quartering off the foundry floor into sections, and systematically keeping the silt condition in the foundry floor uniform in a practical way as part of the foundry routine. He thought that the time had come when every foundry would have tube, and having a small quantity of sand, shaking it in water and allowing it to settle, because, as they were all aware, one could then see a very distinct line where the sand had settled. The heavier grades sank quickly and the silt remained in suspension some considerable time. It might take as long as 24 hours to settle. When, however, one did obtain a distinct line one could take from the sample a comparative test of the amount of silt in one's sand. In three or four cases it had proved extremely valuable to him where there had suddenly developed a patch of dirty casting for no apparent reason, there having been no change in the facing sand. Each time after trying the floor sand that the moulder used by that simple method they had found an amazing quantity of silt in their sand. In each case it was proved afterwards that the man had been on a rather heavier range of casting than usual, and he had turned over his sand rather more. Moreover, for some reason he could not explain, they had used less facing sand. By tipping a couple of barrowfuls of silt-free sand and mixing it in the trouble entirely disappeared. As a result, whenever they got a patch of dirty castings, not scab or gas-holes, but due to dirt, which the moulder always assured one was in the iron, they just took this simple test and satisfied

themselves that the floor sand was in proper condition. It was a very valuable and very simple test. One only had to take two or three tests of sand which was giving satisfactory service and compare the amount of silt in good sand with the amount in the sand one was using. They had heard a lot about the use of the heavy, old-fashioned type of mortar-mill. If one wanted to see the difference it made to the facing sand, they should just take a small quantity of sand and put it in a test-tube before milling, and then take a similar quantity and put it in another test-tube after milling, shaking it up in water and allowing it to settle. He would not say they would get a shock, but they would be very interested to see the surprising increase in the amount of silt in the case of average sand. They might be interested to know that in a foundry in Chicago, producing something like 1,000 tons a week of agricultural machinery castings, the whole of the sand testing was done by that method. They used bottles there. The gentleman in charge of the department, Mr. Smith, took him into his laboratory, and there were rows and rows of shelves all round, with at least 2,000 bottles duly labelled with the simple sedimentation tests. Mr. Smith claimed that he reduced his scrap percentage from approximately 7.8 per cent. to 6.45, or about 1.4 per cent. reduction, which he said was entirely due to these sedimentation tests.

General Substantiation Wanted.

MR. FAULKNER, in replying to the discussion, said that though his practical experience was not nil, the only time he had ever rammed a mould in his life was when he was a student at the University and made some floor plates, so that it was perfectly obvious that he was not in a position to reply adequately to the discussion. In justice to the author, he thought one could demand some substantiation of the statement put forward by the members who had discussed the Paper. They had had the Paper in their hands for a fortnight or three weeks, and they had had the chance of making some simple tests. It had been stated by more than one speaker that M. Lamoureux should have submitted some simple micro-photographs instead of diagrams. Mr. Longden had spoken about the expansion of the mould due to radiation of the heat from the rising metal. He submitted, not having had any practical experience of moulding sands, that they did not expand to any extent whatsoever. He suggested merely from imagination that it would be rather the freeing of the water and other gases from the mould, and he did not think that the expansion which Mr. Longden referred to in such an interesting manner did take place. As Mr. Longden required substantiation of the diagrams, he, on M. Lamoureux's behalf, asked for substantiation of the suggestion as to the expansion of the mould walls. In such a gathering, the part of the Paper which he would have expected to be discussed was the part on scabs. The whole object of the Paper, to his mind, was to impress upon people, who were busy with the fabrication of moulds, that they must avoid mending at all costs. M. Lamoureux insisted that, whenever a mould was mended, it never produced such a good surface, and was even liable to produce a scab. That was a section of the Paper which seemed to escape the notice of most of those who had discussed it. He would convey to M. Lamoureux the interest which had been taken in his Paper, and he was perfectly certain that they would get a most interesting reply from that most charming gentleman.

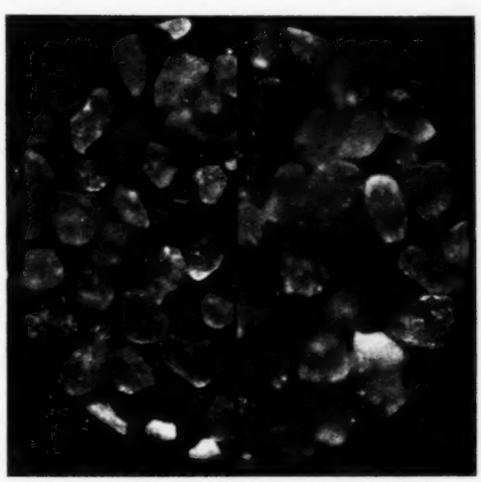
Author's Diagrams Criticised.

MR. ARTHUR LOGAN wrote that the chief charm of this interesting little Paper was the clear and definite manner in which the author's ideas were put forward without any confusing mass of technical data to obscure them. As far as the main statements in the Paper were concerned, they would be fairly generally agreed to, especially the last conclusion, where the author emphasises the desirability of leaving the mould as nearly as possible in the condition in which it was rammed.

Unfortunately, those who were not so well informed as regards the physical structure of sand as it existed in a mould, may be rather misled and obtain some erroneous impressions from diagrams 1 to 4. It was these four diagrams which he wished to criticise in detail. Firstly, he would utter a warning that they should not be taken *too* literally. Possibly the author did not intend that they *should* be taken literally.

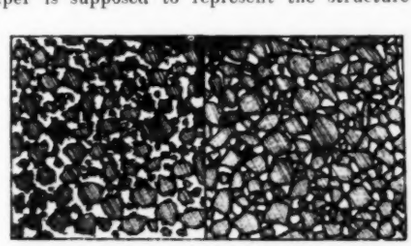
Those who had examined moulding sands would agree that the shapes of the sand grains were rather more spherical, and certainly the grain sizes varied more than these diagrams indicate. The shapes of the grains in Fig. 3, for instance, have more parallel faces than it is customary to find in sands. Fig. A shows the actual shape of sand grains in Yorkshire and Belgian moulding sands after the clay has been washed away.

When foundries received sand from the quarry the grains were unevenly coated with clay, which formed knobbly and wart-like protuberances on the grains. The object of milling, as stated in the Paper, was to distribute the clay evenly over the grains and thus obtain the maximum bonding and porosity value. In the diagrams in the Paper the sand grains were represented by hatched areas, and the spaces between the grains are completely occupied with what appears to represent the clay. There is no indication of the pore or void spaces which are present. As the pore or void space can amount to over 40 per



A.—Yorkshire sand grains washed free of clay. x 50. B.—Belgian sand grains washed free of clay. x 50.

cent. of the total volume, this was a serious omission. An attempt to picture the structure of sand diagrammatically should show these voids. For this reason he referred the author to Fig. B (herewith), which was, he submitted, a more accurate representation of the structure of sand as received and as rammed in a mould than the diagrams shown in the Paper. Fig. 3 in the Paper is supposed to represent the structure of



A.—Sand as received from quarry. B.—Structure of sand in mould after milling and ramming.

sand rammed on the flat, but it resembles more the structure of a stone wall than actual sand grains in a mould. He (Mr. Logan) submitted that there was practically no difference in the structure of sand rammed on the flat and that rammed vertically. Both would have the same arrangement as shown in "B" Fig. B. The main reason why the vertical walls of a mould are rougher is due more to the withdrawal of the pattern than for the reasons stated in the Paper. Some sand always adhered to the pattern, and in withdrawing it this sand was rolled over and over between the pattern and the mould face, thus roughening the surface. The only difference between horizontal and vertical rammed portions of a mould was that in the case of horizontal surfaces the strata of sand rammed to different degrees of density were parallel to the mould face, whilst in the case of vertically rammed faces they were at right angles to it; but it was doubtful if this made any practical difference.

Altogether the Paper was an interesting contribution, and although it did not reveal any new facts about sand, it would be read with interest by all froundrymen.

Company Meetings.

Yorkshire Iron & Coal Company, Limited.—Presiding at the annual meeting in Leeds, last week, MR. J. L. BOOTH, the chairman, said for months last year the directors hesitated whether to close down entirely, but they chose the lesser evil and kept running. The iron trade was in a bad condition, and something would have to be done in this country, whether it was called safeguarding or protection, otherwise he saw no chance for the heavy trades. We could not continue importing iron from Belgium and elsewhere, where less wages were paid. If we could not keep our furnaces fully going, we could not make iron and steel at anything like a profit, or even at cost price. MR. G. MURE RITCHIE (deputy-chairman) said we were faced with a national crisis of the first magnitude, and there could never be any real soundness in the iron and steel industry without safeguarding. Ninety-eight per cent. of the iron and steel manufacturers were in favour of protection; the engineering employers had committed themselves to the policy, and the shipbuilders as a body were not opposed to it. It remained for the bankers and shipowners to look at the question not from a selfish point of view, but from the point of view of national safety and common patriotism.

General Electric Company, Limited.—The annual general meeting was held on Tuesday in London, SIR HUGO HIRST, BT. (chairman and managing director), presiding. The chairman, in the course of his speech, said it appeared their company was one, among others, that had been selected by an American bank for the purpose of dealing in their shares in America. In the ordinary way it did not much interest the board of the company who might be the shareholders in the company, but he believed this to be a matter which required watching. The electrical industry was destined to play a most important part in the development of the Empire. The company held a marked and leading position in the British electrical industry, and it might cause great embarrassment some day if it were found that too big a proportion of shares were held in non-British hands. They therefore proposed to watch, so far as they could, the progress of this movement, and; should they find that an undue proportion of the shares wandered into foreign possession, it might be necessary to introduce measures to keep that movement within certain proportions, so that the control at all times should remain with British shareholders residing within the Empire. As regarded the electrical industry itself, it was full of promise. More than 20 per cent. of their total output went overseas during the last year. For years they had given attention to the equipment of ships, and during the last year the "Bermuda," a liner built in the yards of Workman, Clark & Company, was electrically equipped throughout with apparatus of G.E.C. manufacture. They had previously equipped an all-electrically-manipulated ship for the Admiralty, and were looking forward to great progress in that direction. During the past year they had obtained from the Underground Railway an order for 920 traction motors and control equipment for 63 motor coaches and 107 tractor cars. This was one of the biggest orders ever placed in this country for that class of work. They had a contract for the new power station at Birmingham, which included two turbo-alternators, each of 30,000 kw. capacity, in addition to all the switchgear, transformers and motor generators. The development of Bakelite accessories, produced at their Witton Insulation Works, had brought fresh life into their accessories business.

THE APPLICATION of Mr. C. H. Richards, of 47, Tunnel Road, Llanelly, metal merchant, for discharge from bankruptcy, will be heard on August 1, at the Guildhall, Carmarthen.

E

"Malleable Castings," Processes Examined.*

Mr. J. W. Murray (Wednesbury) wrote that the authors were to be congratulated on such a comprehensive Paper on that subject, but a few of their remarks called for consideration. They stated that the blackheart casting must be different in composition. He did not think that was the case. The following table gave the analysis of four black-heart castings, each from a different firm:—

Analysis of Black-heart Castings after Anneal.

No.	Si.	S.	P.	Mn.	T.C.	C.C.	G.G.	Type.	Tensile strength. Tons.	Elongation per cent. on. 2 ins.
1	0.59	0.06	0.02	0.17	1.65	0.37	1.28	test bar	37 tons	7
2	0.66	0.33	0.09	0.47	2.37	0.15	2.22	casting	—	—
3	0.46	0.21	0.09	0.40	2.65	—	—	casting	—	—
4	0.95	0.09	0.02	0.36	1.83	0.04	1.79	test bar	20 tons	15

These varied widely in composition excepting the phosphorus content, and tended to show that there need not be so much consideration for such low sulphur and carbon contents. There was no doubt that with very low carbon irons the silicon could be raised, and there was some relationship between the two. In cases 2 and 3 the castings spoiled by faulty heat treatment. Appended were two micro-photographs of the same casting. No. 1 showed the casting as delivered to the users. These rejected castings were examined, and one was heat-treated to just above Ac 1 point. The whole structure was refined, as could be seen in No. 2. The refined casting was much stronger and tougher. Malleable ironfounders ought to send out their castings in the best possible condition. Pig-iron makers might give an ideal iron which could be easily ruined by faulty heat treatment: yet so many continued to blame the iron. Malleable castings should be controlled to some extent by the microscope. Greater care was needed with the annealing medium. A casting was broken in two and one half annealed. very doubtful if it would give 90 per cent. bend on the standard bar. The combined carbon content of 0.37 per cent. was responsible for high tensile strength and moderate ductibility. That combined carbon was due to the bad sulphur and manganese balance. A manganese of about 0.37 per cent. would be necessary with that sulphur content to produce an iron which would give normal black-heart physical properties.

Examples No. 2 and No. 3 were not true black-heart malleable, and were apparently attempts to make black-heart from the cupola by raising the manganese content. Such compositions treated as black-heart in the annealing process would give very poor results.

No. 4 was a true black-heart, and agreed fairly well in composition with the requirements stated in the Paper. The physical tests were satisfactory, although the tensile strength would be expected to be higher, considering the composition. It was, however, probable that the iron had been annealed at a high temperature, and that free carbon was present in large nodules, which would account for a strength of no more than 20 tons.

The statement that the essential difference between the two malleables was in the one case the removal of carbon and in the other the deposition of free carbon was substantially correct; but the statement that that depended on annealing only was definitely wrong. Graphitisation had been dealt with sufficiently in the Paper to show that an iron which would readily graphitise did not make a good white-heart, and that an iron which

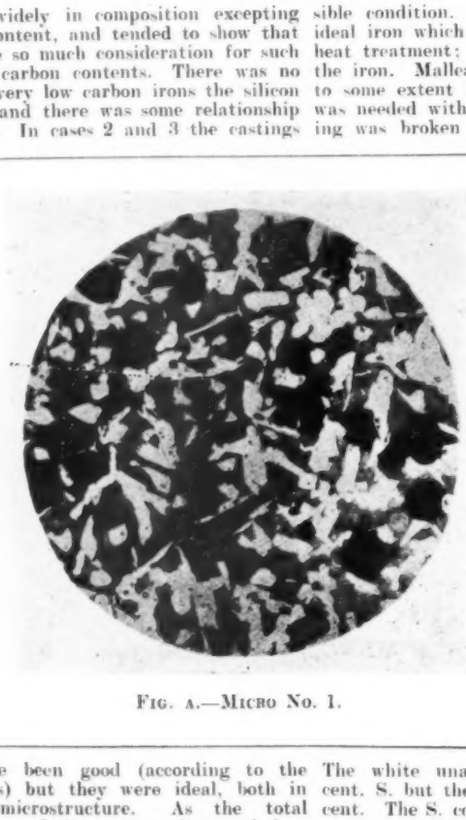


FIG. A.—MICRO NO. 1.

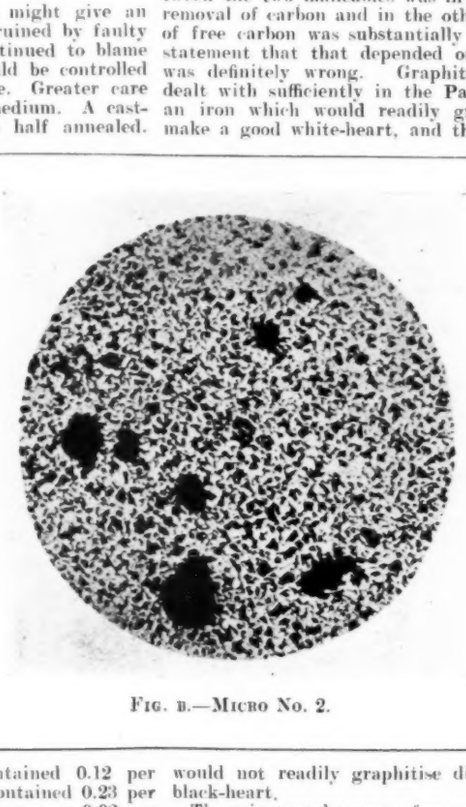


FIG. B.—MICRO NO. 2.

should not have been good (according to the author's remarks) but they were ideal, both in fracture and microstructure. As the total carbon of No. 3 was 2.65 per cent., it was obvious that the original casting before annealing was at least 3.10 per cent., because the picture frame contained very little carbon. The essential difference appeared to be not chemical composition, but the method of annealing: on the one hand the removal and on the other the deposition of carbon.

Common sense told them that higher carbon in the iron would affect the time of annealing whilst too little carbon would give difficulties in producing good sound castings. A carbon content of 2.90 per cent. to 3.30 per cent. yielded the best all-round properties affecting time and temperature of anneal, other constituents being suitable. The limitation of carbon content and control of other constituents involved the use of refined irons to secure the best results.

Effect of Heat Treatment.

Malleable casting suffered from ingotism just as other cast products did. Many of them were

* A Discussion on a Paper, "Malleable Castings," prepared for Leicester Conference of the Institute of British Foundrymen, by W. T. Evans and A. E. Peace.

The white unannealed half contained 0.12 per cent. S. but the annealed half contained 0.23 per cent. The S. content of the new ore was 0.02 per cent.: that of the used ore was 0.21 per cent. The scale adhering to the pans was 0.29 per cent. Should any of that scale find its way into the used ore, it appeared finally to migrate into the castings via the ore. That scale should be kept from the ore.

He asked the authors the following: "When a blackheart casting was to be subjected to a further operation, involving heat effects such as brazing, did not the work done cause the carbon to be taken into the solution, which on cooling forms a zone of pearlite or a high-carbon steel structure, thus restricting all post heated casting to white-heart malleable?"

Effect of Brazing.

MR. EVANS, in replying to Mr. Murray, could not agree with the suggestion that good black-heart could be satisfactorily made from metal of very variable composition, and that much consideration need not be given to low sulphur and carbon contents. Taking the four examples of which Mr. Murray gave the analysis, No. 1 was a very inferior black-heart, and did not equal the B.E.S.A. specification for elongation, and it was would not readily graphitise did not make good black-heart.

The micrographs were of a very poor malleable, apparently an attempt to make black-heart with a high sulphur iron. The refinement had admittedly improved the iron, but had not made it into good malleable. With reference to the question of after-heat treatment of malleable, they pointed out that any heating which involved a temperature of about 720 deg. C. or more would render a black-heart casting brittle. With white-heart the embrittling effect was very much less, and on thin sections, which frequently had been decarburised by the annealing process, the malleability was not impaired at all. A small cycle part would not be suitable in black-heart if it had to be brazed on to the frame. With well annealed white-heart there was practically no carbon there, and one did not get the carbon going back into the solution owing to the effect of brazing.

Malleable from Refined or Virgin Pig-Iron.

MR. E. LONGDEN said with regard to the production of malleable iron he would like to endorse all that had been stated in the Paper. Undoubtedly they should be proud of the presence of those two gentlemen as representing a company which was far ahead of any other malleable-iron foundry

in Europe, and he would say comparable with anything American. In connection with the raw material, he would ask the authors whether they could produce the best quality of malleable iron from refined iron. His experience was that best pig-iron for malleable work was produced from natural ores, and he thought that was the experience of a number of makers. On page 3 of the preprint, the authors said it was sometimes advisable to change the mixture, apart altogether from analytical considerations, as the fluidity and life of the iron might not be all that was desired. But, in his opinion, there must be some inherent properties in the raw virgin metal. Whether or not it was due to some effects of gases in the metal, he was not at all sure; but he would like the authors to enlarge upon that portion of their Paper.

Manganese-Sulphur Ratios.

MR. J. G. PEARCE thought all those who had read the Paper carefully would agree that it represented the best Paper ever given in England on black-heart malleable, and they should congratulate the authors accordingly. In all probability, it would become the standard Paper for the future. On page 10 of the preprint, in the first column, the authors suggested that low sulphur white-heart graphitised rather than decarburised, and they gave a result not much better than the weak grey iron. Perhaps the authors could explain a result of that kind, which recently had been obtained in some tests by the Research Association, which was as follows:—Iron of 3.0 per cent. total carbon; 0.06 per cent. silicon, with only 0.015 per cent sulphur—made to Besa specification—but which gave 10 per cent. elongation and 120 degrees bend on the standard bar. It decarburised and the degree of carbon removal was 70 per cent. on 120 hours' annealing, which they would regard as normal for a material of that thickness. He did not call that weak malleable. He did not call it malleable which contained the property of weak grey iron by any means.

Referring to manganese, the authors said that it had been found by experience that the atomic ratio of 1.72 times of sulphur (managanese sulphur ratio) gave the best working conditions. He would be glad if the authors could amplify that, because in Papers published in 1925 and 1927, Mr. E. R. Taylor showed that the manganese sulphur ratio should be 1.71. In point of fact these Papers, with some additional work, were summarised at the Sheffield Convention last year. Judging from the work which had been done since then, he believed that that ratio required modification. It would be particularly helpful if the authors could pick out from their experience say a dozen bars of varying manganese sulphur ratio, and so confirm the original view that 1.71 manganese sulphur ratio was based on physical tests. That was rather an important point at that moment.

Improved Grey Iron Available.

MR. J. SHAW also emphasised the value of the Paper. He was not a malleable expert, so from that standpoint he could not offer much to what had been said. From his recent visit to America he had found that a great advance was being made with grey iron from the use of air-furnace metal. He visited some works a fortnight ago, where they were practically making 100 tons a day from air-furnace metal. In one particular case they had ousted steel, due entirely to the better qualities from that type of metal. He put forward that as a suggestion as grey-iron founders generally were losing work, due to welded material from condensers of that kind, a factor which was hitting them very badly. There was no doubt this American firm had built up a special grade of metal for general application, but especially for brake-shoes for heavy duty, which enabled them to cast 100 tons per day of that particular material by means of which they had ousted steel castings practically all over America. There was one point on which he would like some information. He referred to what had been said on page 4 of the preprint: "This material is regularly being machined to fine limits, and small additions of manganese, in the form of 80 per cent. ferro-manganese, to the ladle when pouring improve its machining qualities with little change in the analysis." He would be glad if Mr. Evans or Mr. Peace would give their views as to what effect manganese had with very low sulphur of that type with regard to increasing the annealing qualities of that metal.

Sulphur-Silicon Ratios.

MR. F. J. COOK said that reference had been made to the ratios of manganese and sulphur, with a view of eliminating a type of hardness, which prevented easy annealing. In white-heart malleable he had been interested in the ratio of the silicon to the sulphur. In observations over a long period he had found many instances where that was the great ruling effect. It would be interesting if others would look through their records and see if they could find the ratio of silicon to sulphur, or sulphur to silicon, which seemed to have any beneficial effect in black-heart.

MR. F. K. NEATH said that on page 9, column 3 of the preprint, the authors, under the heading of sulphur, stated that the sulphur in black-heart must necessarily be kept very low, owing to the fact that it retarded the graphitisation. They also stated that manganese was useless for neutralising the sulphur. He recently saw in an American journal that manganese was being eliminated, and that cerium was being added. The excess cerium used to neutralise the sulphide did not have the harmful effect apparently that excess manganese had. He wondered if the authors had heard of that, or had had any experience of it, as it seemed to him quite an interesting development.

Factors Affecting Fluidity.

MR. A. E. PEACE, replying to Mr. Longden's remark as to refined iron, stated that it was some years since Mr. Evans had been actively engaged on white- heart malleable, so that for the present Paper neither Mr. Evans nor himself had had a great amount of white-heart material to draw upon; and they had had to rely on data which had been sent to them by various friends. As to refined iron, he might make reference to two Papers given by Mr. Hurren and Mr. Field, in which they both stated that they could make better quality white-heart with refined iron than they could with unrefined iron. It was certain that one could get more accurately to an analysis with refined irons than one could with ordinary natural hematite, unless very great care had been exercised in its selection. With regard to fluidity, and occasionally making a rather large alteration in the mixture in black-heart malleable because of loss of fluidity, Mr. Longden had suggested that it was a matter of inherent properties. That might very well be so. In malleable it was the custom to re-melt a large quantity of scrap. The feeders and runners, as mentioned in the Paper, were very considerable, and they were re-melted with a charge; so that if new pig-iron were introduced, one gradually got a cumulative effect of any harmful element which one could not remove from that iron. It was that which happened when they occasionally saw signs of loss of fluidity.

Initial Composition.

Mr. Pearce had criticised the range of analyses on page 4, but he would point out that that was a range of pig-irons which were suitable, and which might be used. He thought Mr. Pearce would agree that an enormous amount of pig-iron was absorbed in the malleable-iron industry to-day with carbon up to 3.8; but he did not suggest for a moment that white-heart malleable should be made from 3.8 per cent. carbon. The scrap which was utilised would be somewhere about 3 per cent., and would reduce that 3.8 pig-iron down to some extent. Mr. Pearce had quoted the 3 per cent. total carbon content, 0.06 silicon and 0.015 sulphur white-heart annealing satisfactorily with 70 per cent. removal of carbon as giving good tests. Mr. Pearce did not mention the manganese content, but he presumed it was exceedingly low.

MR. PEARCE replied that it was low.

Theory of Graphitisation Chaotic.

MR. PEACE said it did not have to be very much lower than the ordinary white-heart grades to make void the remark in the Paper that Mr. Pearce was bringing into question. Whilst the paper had not dealt very extensively with graphitisation, there seemed to be much difference of opinion on the subject of graphitisation, which was the main basis of white-heart or black-heart malleable considerations. He had the conception in his mind that if an iron would readily graphitise, it was more difficult to remove the carbon than if it would not readily graphitise. The only suggestion he would make with reference to Mr. Pearce's iron was that it would not readily graphitise in spite of apparent suitable analysis. Mr. Pearce had not mentioned any chromium content, or any other elements which might restrain graphitisation, such as vanadium. Up to that moment, though he had been searching for eight years to find pig-iron without any chromium, he had never discovered it. He had tried pig-irons from Great Britain, Sweden, India and America, and had not yet discovered one free from this element. As to the manganese ratio 1.72 times sulphur, for that data he cited the previous work of Mr. Evans when engaged on white-heart malleable, and the work of Mr. Hurren, which stated that that was the figure which he worked to, and also the research work of Mr. E. R. Taylor. He was not in touch with all the subsequent work which the Cast-Iron Research Association had done. With regard to Mr. Shaw's question asking what was the effect of manganese in softening the white-iron of low sulphur white-heart, he could only say he really did not know. When Mr. Shaw got up and asked a question, one could be pretty sure that there was no published answer to it. But, very definitely, one obtained an increase of temperature when one added manganese to low-sulphur iron in the ladle, and there was a considerable evolution of gas which might have something to do with the softening effect which undoubtedly was very marked. As to Mr. Cook's reference to the silicon to sulphur ratio, he must say that he had not considered that at all, and could not say that he had noticed any definite ratio which gave good results in black-heart. In answer to Mr. Neath's suggestion whether any cerium had been used in place of manganese to overcome the harmful effects of sulphur, he heard some years ago that a number of other elements were being tried out in black-heart malleable in the States, but the names at that time were not divulged, and since then he had not had any communication on the subject.

Reports and Dividends.

Darlington Forge, Limited.—Net profit of £3,144, reducing the debit balance brought in to £206,907.

Millom & Askam Hematite Iron Company, Limited.—Payment of the dividend on the 7 per cent. cumulative participating preference shares is postponed.

Fawcett, Preston & Company, Limited.—Final dividend of 10 per cent. on the ordinary shares, making 15 per cent.; to reserve, £14,080; carried forward, £7,472.

Marshall, Sons & Company, Limited.—Net profit, £24,001; brought in, £2,818; written off plant, £3,915; written off issue expenses, £5,306; off investments, £3,500; carried forward, £9,097.

Thomas & Isaac Bradley, Limited.—Loss, after providing interest on loan, £936; debit balance brought forward, £35,509; less £1.651 directors' fees waived by the board; making a debit balance to be carried forward of £34,795.

W. T. Henley's Telegraph Works Company, Limited.—Net profit, after meeting debenture interest and depreciation, £283,074; income-tax, £31,846; reserve account, £50,000; final dividend of 2s. 6d. per share, less tax, making 4s., with a cash bonus of 1s. per share, less tax; leaving £532,930 to be carried forward.

Petters, Limited.—Net profit, after providing for depreciation, etc., £25,634; brought forward, £24,810; preference dividends, £12,000; interest on funding certificates, £1,670; funding certificate redemption fund, £829; ordinary dividend of 6 per cent., less tax, £5,400; to reserve fund, £5,000; carried forward, £25,545.

Bradley & Foster, Limited.—Net surplus, after providing interest on debentures, £3,979; brought forward, £791; to reserve for income-tax, £250; reserve for bad debts, £500; depreciation reserve fund, £2,500; net profit, £229; carried forward, £1,020. The directors do not recommend a dividend on the preferred ordinary or ordinary shares.

XUM

A Comparison of the Most Important Methods Employed in the Cleaning of Blast-Furnace Gas.*

By V. Harbord (London).

The large amount of gas evolved from the blast-furnace plant has been one of the main difficulties met with in the design of cleaning plants, but there are at the present day several very satisfactory cleaners working, whereby enormous direct savings are being made in the actual use of coal throughout the works, and indirect savings in repairs in hot-blast stoves, boiler cleaning, and general efficiency in the plant. Although results obtained from individual plants have been published, so far as the author is aware no independent detailed works results over a reasonable period of a number of plants are available, from which a comparison of the relative efficiencies of different types of plants can be made. It was thought that actual operating figures would be of interest, and with the consent of the directors and the co-operation and assistance of the staffs of a number of works in this country, the actual works records have been placed at the disposal of the author, the information given as to the general results thus obtained being embodied in this Paper.

Gas-cleaning plants may be conveniently classified in two main classes—dry cleaners and wet cleaners—and the former can be further subdivided into those which filter the gas and those which remove the dust from the gas by electrical precipitation.

The best-known dry cleaners of the filtration type are the Halberg-Beth and the Kling Weidlein wire-mattress cleaner, whilst the Lodge-Cottrell is the only type of electrostatic cleaner which has established itself in this country.

The wet-cleaning plants at work in this country are frequently of composite design, but they all depend essentially on getting an intimate mixture between a fine spray or mist of water and the gas, either by means of spraying or scrubbing in towers or by fan disintegrators of the Theisen type, or by a combination of both.

Another distinction which is frequently made between types of gas cleaners is between those which are capable of treating the gas hot and thus preserving the sensible heat, and those which necessitate cooling the gas prior to cleaning; of the former the electrostatic and the Kling Weidlein are the most important examples, and considerable importance is attached by the patentees or manufacturers to this saving in sensible heat. This advantage is not so great as may appear at first sight, as the gases at the higher temperature are capable of carrying a larger amount of water vapour, which will retard combustion. By cooling the gases below their dew point, water will to a certain extent be removed, and the loss of sensible heat will be partly balanced by obtaining a dryer gas for combustion, notwithstanding the intimate contact with the water during cleaning.

There are great difficulties in comparing the results obtained by the various types of cleaners, as few types are designed to clean down to the same extent, nor are the conditions under which each is operating similar in all cases. The quantity, quality, and fineness of the dust all have a considerable bearing on the question, as it is obviously an easier matter to remove the coarser particles than the extremely fine material, and the variation in the dust from the same furnace from hour to hour makes it extremely difficult to generalise. Again, it is manifestly unfair to compare the relative cleaning efficiency of a Kling Weidlein apparatus with that of the Halberg-Beth, as the former is only claimed to act as a primary cleaner.

With certain types of cleaners—more especially those of the wet type—a certain amount of latitude is possible in this respect by regulating the amount of water used, and it is a matter for the management to decide at which point the benefits obtained from additional cleaning become no longer economical.

When comparing the results obtained from different types of cleaners, the dust content of the final gas is the most suitable basis of comparison, bearing in mind, of course, whether the apparatus is designed as a primary or a final cleaner. Somewhat misleading figures are sometimes given under the name of "efficiency," as expressed in the percentage of the dust extracted; almost any type of dust-catcher will extract coarse dust, and the efficiency so defined will depend almost entirely on the relative coarseness and the quantity of the dust in the crude gas. With a dirty gas a good "efficiency" can thus be shown, although the resulting cleaned gas may still contain a large amount of dust. The desired object is to obtain a gas which does not contain more than a certain amount of dust after cleaning, and this should be the basis of comparison.

The dust contents in the gas reported in this Paper were not determined in all cases by the same apparatus at the different works; different methods were adopted as the result of individual experience. With skilled operators the differences in the methods employed in sampling should not appreciably affect the results obtained.

In the choice of a suitable cleaning plant, there are a number of points in addition to the actual final dust content of the gas which require careful consideration, such as power consumption, water supply, disposal of dust, and whether the dust is of any value for briquetting or for the recovery of potassium salts.

With wet cleaners, when the quantity of water is limited or the flue-dust is required for briquetting purposes, the installation of the Dorr thickener in conjunction with the cleaning plant enables the greater portion of the water to be recirculated, and the dust can be collected in the form of a thick sludge and run out into storage bays and dealt with as desired.

It was hoped at first to get definite information as to the indirect savings obtained by the various methods of cleaning, but this has proved too difficult to compute with any degree of accuracy, as there are so many factors which affect the results. In some cases, coincident with the installation of cleaning plant, hot-blast stoves have been redesigned, different filling bricks put in, and new and more efficient types of burners have been introduced, all of which improvements have led to saving. On the other hand, full benefit is not being obtained in some cases, owing to the gas not being fully utilised pending alterations to other parts of the works. It is therefore practically impossible to estimate the indirect saving in refractories and repairs, due to the introduction of gas cleaning, which has, however, even under unfavourable conditions, more than justified itself by saving in cost of repairs and maintenance. In some cases a smaller number of stoves are being used and a higher blast temperature maintained, giving a greater blast-furnace efficiency.

A short description of each type of cleaner is given below, together with any special works conditions considered likely to affect materially the results obtained.

Wet Cleaning Plants.

I.—Scrubber and Fan Washer.—This plant is designed for cleaning gas for gas engines, and is cleaning 600,000 cub. ft. of gas per hour from 4 to 5 grm. down to 0.02 grm. per cub. m. The dirty gas enters the water-spray cooling towers at a temperature of 190 deg. C., is cooled down to 37 deg. C., and leaves with a dust content of 0.8 to 1 grm. per cub. m. It then passes to a Jenkin fan in which water is injected in a fine spray, and, leaving this with a dust content of from 0.2 to 0.3 grm. per cub. m., it is finally cleaned to 0.02 grm. in a Theisen washer. The power consumed in this plant is 160 kw., which is equivalent to 0.275 unit per 1,000 cub. ft. of gas cleaned; the water used for the same quantity of gas is about 30 gallons. The cost for labour, power, stores, and repairs for this plant, according to works records for a three months' period, was 0.195d. per 1,000 cub. ft.

II.—Scrubber and Disintegrator.—This plant is cleaning gas only for stoves and boilers, soaking pits, etc., and although the plant was designed for dealing with only 800,000 cub. ft. per hour, it is actualy cleaning 1¼ million cub. ft. The crude gas containing 4 to 5 grm. per cub. m. is cooled in a Zschocke tower from about 80 to 140 deg. C. to 36 deg. C. It is then passed either into a Zschocke fan, which reduces the dust content to 0.25 grm. per cub. m., or to a new Theisen disintegrator by which the dust content, if determined at a distance along the main at which all the spray has settled, is found to have been reduced to approximately 0.02 grm. per cub. m. The power and water consumed on this plant per 1,000 cub. ft. of gas cleaned are respectively 0.08 unit and 11½ gallons when using the Zschocke fan, but with the Theisen disintegrator 0.13 unit and 13½ gallons are required. The total cost for labour, maintenance, and power on this plant over a prolonged period was given as 0.0896d. per 1,000 cub. ft. of gas cleaned. During this period both the Zschocke fan and the Theisen disintegrator were working at different times.

III.—Wet Cleaner with Scrubbers, and Disintegrators.—This plant is designed to wet-clean the gas from four blast furnaces, and is treating rather more than 5,000,000 cub. ft. per hour. The gas containing from 2 to 3 grm. per cub. m. is collected in a common main 9 ft. 3 in. in internal diameter, and enters three scrubbers at a temperature varying from 100 to 200 deg. C. These scrubbers are 72 ft. high and 15 ft. in diameter, and are packed with 134 tiers of wooden grids with 1½-in. spacings. Water is impinged on to a cast-iron plate from eighteen 2-in. nozzles to form a fine spray. The gas passes from the scrubber to three Theisen washers, each capable of dealing with 2,118,000 cub. ft. of gas per hour at N.T.P., and is finally dried in three cyclone dryers 7 ft. in diameter and 16 ft. high, from which it is taken to the clean gas main and distributed to stoves and boilers. The clean gas leaves at a temperature of about 40 deg. C. and contains from 0.03 to 0.04 grm. of dust per cub. m. About 40 per cent. of this gas is finally washed for gas engines in an old Theisen plant, but the power and water figures given apply only to the gas cleaning down to the condition required for stoves and boilers. The sludge from the cleaning plant is taken to a Dorr clarifier which enables nearly 90 per cent. of the water to be recirculated. The clarifier, further details of which are given later, is 86 ft. in diameter and deals with 5,000 gallons per minute, and the clarified water passes to settling ponds, where it is cooled by one hundred and twenty ⅜-in. sprays and recirculated. The thickened sludge is disposed of as a waste product.

The power used by the circulating pumps and Dorr thickener is 0.038 kw.-hr. per 1,000 cub. ft. of gas cleaned, and for the three Theisen washers 0.18 kw.-hr., giving a total of 0.218 kw.-hr. per 1,000 cub. ft.; the water circulated and the make-up water are respectively 5.4 gallons and 0.6 gallon per 1,000 cub. ft.

The plant has only recently been put into operation, so that maintenance and repairs are practically negligible. The labour required is two men per shift, which entails a charge of 0.006d. per 1,000 cub. ft. of gas cleaned. The water is obtained from the river, so that the direct cost of cleaning the gas to the required condition for stoves and boilers works out, on the basis of power at ½d. a unit, as 0.115d. per 1,000 cub. ft. of cleaned gas.

IV.—Brassert Tower and Theisen Disintegrator.—This plant, which has only recently been started up, and will probably be considerably extended, has a capacity at present of 2,500,000 cub. ft. per hour, and is cleaning rather more than 2,000,000 cub. ft. per hour to the extent required for stoves, boilers, soaking pits, and reheating furnaces.

The plant consists of a single Brassert tower with sprays and hurdles to break up the water and gas. The tower is about 70 ft. high and 14 ft.

* A Paper read before the May Meeting of the Iron and Steel Institute.

in diameter, and the water circulated is about 50 gallons per 1,000 cub. ft. of gas. The gas, containing about 6 grm. of dust per cub. m., enters the tower at a temperature between 180 and 240 deg. C., and leaves at about 20 to 25 deg. C. It then passes to one of two intermediate dryers in which the excess of moisture is removed by a sudden reversal of the gas flow and by the gas impinging on fresh surfaces. The gas is then taken to one of two Theisen disintegrators, the second being in reserve as it is found necessary to thoroughly clean them out about once in six months. The water circulated in the Theisen machine is about 5 gallons per 1,000 cub. ft. of gas cleaned. The gas is then passed into one of two Bischoff dryers by which the mechanically-held moisture is removed by baffles and frequent reversals of the direction of flow of the gas. The final gas contains from 0.15 to 0.20 grm. of dust per cub. m. under the present working conditions.

An interesting series of tests was carried out at this plant on the effect of varying the quantity of circulating water in the tower and in the disintegrator; they showed that in both parts of the cleaner the quantity of water could be very considerably reduced without any reduction in the cleaning of the gas, but in practice it has been found that if the minimum amount of water be used, which is about 25 gallons on the tower and 3 gallons on the Theisen machine per 1,000 cub. ft., the Theisen disintegrator rapidly furs up. This plant is so situated that the charge for the water supply represents only the cost of the power for circulation, and this amounts to a difference of only about 0.01 unit per 1,000 cub. ft. for the additional water. The actual power used was given as 0.15 unit per 1,000 cub. ft. The labour to run the plant is two men per shift and supervision which amounts to 0.024d. per 1,000 cub. ft.

As regards repairs and maintenance, the plant is practically new, and has only been running a few months, so that no figures are available, but it would appear that these should be very low, as the whole system consists merely of circulating pumps. The six-monthly clean and overhaul of the Theisen is carried out by the operators on the plant with the help of fitters, etc., and is estimated to cost about £4 to £5 each time. The capital cost of this plant was about £17,400.

V.—Brassert Scrubbers and Sprays without Disintegrators.—This plant is similar in some respects to Plant IV, in that it is a Brassert washer, but it differs in that Theisen disintegrators are not installed in conjunction with the towers. The plant consists of two Brassert washers 15 ft. in diameter, No. 1 being 86 ft. high and fitted with a bottom cone, and No. 2, of later design, being 65 ft. high and having no such cone, and has a capacity of about 5 million cub. ft. per hour. At present No. 1 washer only is in use, owing to the blast-furnace plant not being in full operation, and 2¾ million cub. ft. of gas are being cleaned per hour. The tower is packed with wooden hurdles on to which jets of water are sprayed, the gas in its upward journey being intimately mixed with the down-flowing spray of water. The gas before leaving the tower is subjected to a high-velocity water spray, and after being made to turn a number of double bends it enters the dryer or mud catcher tangentially. This is a cylindrical chamber, the bottom of which tapers into the down-comer main for the gas. The centrifugal force due to the tangential entry throws the coarser moisture particles to the sides of the cylinder, and this is assisted by a high-pressure spray of water in a very fine state of division impinging on the stream of gas from above which serves as a carrier of the moisture particles to the sides of the tube. This moisture-containing fine dust is trapped in an expanded part of the down-comer, and is drawn off, the cleaned and partially dried gas passing along the main, where it is further dried by a sharp change of direction at the bottom of the down-comer. It then enters the clean-gas main feeding the stoves, boilers, etc. This main is fitted with drain cocks every 50 ft., which are opened every 24 hours. Fig. 1 is a sketch showing the construction of the Brassert tower and spray dryer.

The water and sludge are taken in an open culvert to the Dorr thickener, which is 86 ft. in diameter. The clarified water passes to a hot well, and is then pumped up into a cooling tower and recirculated. The sludge is run out into bays and allowed to dry; it is proposed to put down a sintering plant to treat this material for the blast-furnace plant.

The gas, containing 5 to 6 grm. of dust per cub. m., first enters a primary dust catcher of the cyclone type and then enters the Brassert tower. It enters the clean-gas main with a dust content of about 0.4 to 0.5 grm. per cub. m.

The total water required for the operation amounts to 29 to 37 gallons, and the power required is 0.029 unit per 1,000 cub. ft. of gas cleaned. The make-up water due to wastage and loss with sludge amounts to approximately 5 per cent., say 1½ to 2 gallons per 1,000 cub. ft. of gas.

In an appendix to the Paper the author gives a table showing the results obtained with a No. 1

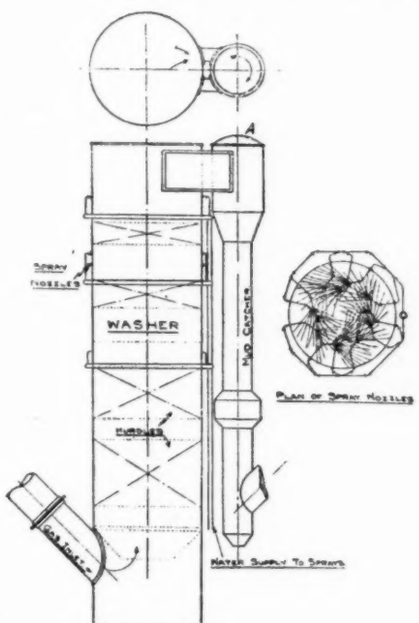


FIG. 1.—BRASSERT WASHING TOWER AND MUD CATCHER.

The gas on leaving the spraying tower, in which the coarser dust is removed, enters the mud catcher tangentially, whereby some of the moisture, carrying dust with it, is deposited on the sides of the tube. The atomising water spray at *A* impinging on the gas from above at high pressure carries the finer moisture particles to the tube surface. The wet slurry is trapped in the expanded part of the tube and withdrawn.

Brassert tower during the months of October and November, 1927. In October the dust content of the cleaned gas varied from a maximum of 0.706 to a minimum of 0.199, and in November from a maximum of 0.520 to a minimum of 0.252 grm. per cub. m. The average temperature of the inlet water to the tower was 20 to 25 deg. C., the average temperature of the clean gas leaving the plant, 20 to 25 deg. C., and the average temperature of the overflow water from the Dorr thickener, 10 to 13 deg. C. The labour in this plant is not considered, as the pumps have all been installed in the existing pump house and have entailed no extra men for operation. The washery itself is visited by the stove tenders at regular times, but no extra men have been employed since the plant was put into operation. Actually a proportion of these men's time should be allocated to the gas-cleaning plant, but it was not possible to obtain any figure for this. As regards repairs, the plant has only been running a few months, and no figure can as yet be given.

A short description of the Dorr clarifier as installed to deal with blast-furnace slurry may be of interest. The apparatus installed at Plant V consists of a circular tank 86 ft. in diameter into which the slurry is brought. There are four arms fitted to a vertical rotating shaft, two long and two rather shorter, which make one revolution in 20 minutes, drawing the settled sludge to the centre, whence it is discharged by special sludge pumps. The power expended is very low, and is included in the figure given above. A typical test of the clarifying effect of this apparatus is as follows:—Inlet water, 32.45 grains per cub. ft., suspended solids, 98.42 in solution; outlet water, 3.39 grains per cub. ft. suspended solids, 93.91 in solution.

The amount of dried sludge obtained from the Dorr thickener is about 3 tons per day, of which the following is a typical analysis:—FeO=23.04 per cent., and Fe_2O_3=37.43 per cent., total iron=44.20 per cent.; SiO_2=10.48 per cent.; CaO=4.60 per cent.; MgO=trace; SO_3=1.45 per cent.; P_2O_5=0.133 per cent.; MnO=1.67 per cent.; Al_2O_3=11.40 per cent.; loss on ignition=8.40 per cent. The capital cost of the Brassert towers, Dorr thickener, etc., was given as £30,000.

Dry Cleaners.

VI.—Lodge-Cottrell, Pipe Treater Type.—This plant was designed to clean 2,000,000 cub. ft. of gas per hour, but as the output of the blast furnaces has been increased since its installation, it is estimated that it is dealing with about 3,000,000 cub. ft. of gas per hour. It is of the "pipe treater" type, and consists of six compartments, each containing 64 pipes, through which a nichrome wire is suspended from an insulator above. The dust is deposited on the inner walls of the tubes by the electrical discharge. Each battery of tubes is fitted with its own separate electrical unit, and is mechanically rapped every hour to shake the dust down, the current being temporarily cut off. It is probable that a considerable amount of the dust which is found in the clean gas test is brought over immediately after opening up the compartments after rapping, as it is not possible in practice to give the dust sufficient time to settle completely in the hopper after rapping.

The plant has been in operation for some years, and considerable difficulties were met with in the early stages in the choice of suitable wires for the discharge electrodes; this difficulty has now been overcome by the use of nichrome wires. The author was also informed that considerable improvements have been made in the rectifiers and insulators, which now give very little trouble. The gas enters the cleaner containing on an average 5 to 6 grm. of dust per cub. m., and at a temperature of from 180 to 230 deg. C.; it is cleaned down to a dust content of from 0.4 to 0.6 grm. per cub. m., and leaves the apparatus at a temperature of from 120 to 180 deg. C. It was stated that the inlet temperature could rise to 425 deg. C. without causing trouble. Details of tests taken over a period of one month are given in an appendix to the Paper, and from these it appears that the dust content before cleaning varied during the month from a maximum of 7.30 and a minimum of 3.30 grm. per cub. m. before cleaning to a maximum of 0.66 and a minimum of 0.34 grm. per cub. m. after cleaning. The gas temperatures were 260 (max.) and 178 (min.) deg. C. before cleaning, and 188 (max.) and 118 (min.) after cleaning.

The dust content is considered to be higher than would be the case if the plant were working to its designed capacity, but, on the other hand, the cost of cleaning per 1,000 cub. ft. would be materially increased. The considerable difficulty encountered at first in handling the dry dust from the apparatus has been overcome by discharging it into a culvert and flushing it away by water; by this means the labour is reduced.

One chamber is laid off every month for a complete clean out and overhaul. The power used in the plant amounts to about 0.013 unit per 1,000 cub. ft., and the labour required is three men per shift and a foreman on day shift. The cost of labour amounts to 0.0181d. per 1,000 cub. ft. of gas cleaned.

Stores and repairs over a period were given as costing 0.0023d. per 1,000 cub. ft., and the overall cost of cleaning—power, labour, and repairs, stores, renewals—amounted to 0.026d.

XUM

The capital cost of a similar plant at to-day's prices would be approximately £30,000.

VII.—Lodge-Cottrell, Plate Treater Type.—This plant is composed of eight chambers, through which the gas is passed in parallel. The insulated wires are suspended between vertical plates which take the place of the tubes in the pipe treater type; the dust is deposited on the plates by the electric discharge from the insulated wires, which are charged with unidirectional current at high tension. Each chamber is fitted with two sets of plates, the gas being thus cleaned in two stages. About 2,000,000 cub. ft. of gas per hour containing about 5 grm. per cub. m. are passed, and the cleaned gas, carrying on an average 0.4 grm. per cub. m., is used under stoves and boilers. Trouble was encountered in the early days with the breakage of the insulators, but improvements have increased the average life of an insulator to about 12 months. The dust in this plant is removed by hand labour, and is rather difficult to handle owing to much of it being very fine in character; a considerable proportion of the wages cost is spent in dealing with this material, which at the present time has no market value.

The amount of dust recovered per week amounts to about 35 tons, which is equivalent to approximately 3.75 grm. per cub. m. of dust cleaned, and forms a fairly accurate check on the percentage extraction of the plant.

The cost of power consumed on the plant over a period was given as 0.03d., wages 0.014d., insulators 0.001d., repairs and stores 0.0015d., making the total actual working costs for this plant 0.0465d. per 1,000 cub. ft. of gas cleaned. The capital cost of the plant was given as £20,000.

VIII.—Lodge-Cottrell, Plate Treater Type.—This plant is designed to treat 6,000,000 cub. ft. of gas per hour. It consists of twelve chambers working in parallel; each chamber is fitted with four banks of electrodes, the two banks on the crude side being worked in each case from electrical units separate from those on the clean-main side, so that one side of the treater acts as a crude dust cleaner and the other side as a final dust cleaner. The installation consists of six electrical units, but only four have been put into service, as the plant has not yet operated at full capacity owing to the blast-furnace department not working at its maximum output. Two of the electrical machines operate the crude-gas side of the plant, the others the semi-clean-gas side. The dirty gas usually contains from 4 to 6 grm. of dust per cub. m., and enters the plant at about 200 deg. C. A drop in pressure of 0.5 to 0.6 in. water-gauge, and in temperature of about 100 deg. C., occurs during its passage through the apparatus, and a final dust content of about 0.3 grm. per cub. m. is usually found in the clean gas.

At these works the blast-furnace practice varies considerably from time to time, according to the varying proportion of calcined and raw ore used, and this has a very considerable bearing on the dust content of both the dirty and clean gas. In an appendix is given a table showing the results of a series of actual tests carried out on different ore burdens illustrating this effect. Table I reproduces this in abstract.

The labour required to operate the plant is one man per shift, and one man cleaning out on day shift only. The dust is withdrawn in the dry state from the hoppers into wagons and is somewhat difficult to handle; it has no market value. The power required to work the plant (that is, 4 machines) is 0.0225 unit; wages, including dust disposal, cost 0.0063d., and stores 0.0017d. per 1,000 cub. ft.

The plant has only been put into operation comparatively recently, and, as is frequently the case, there has been a certain amount of trouble in the early stages; consequently, maintenance, replacements, and engineers' time on the plant have been considerably in excess of what will be normally expected, and these figures are therefore not included. It is believed that these troubles were only such as are usually met with in starting up a new plant, and that before long they will be to a great extent overcome. The capital cost of this plant was given as £55,000.

IX.—Halberg-Beth Filtration Plant.—This plant is treating approximately 2,000,000 cub. ft. of gas per hour, containing about 3 to 4 grm. of dust per cub. m. The gas first enters the towers, in which it is air-cooled to a temperature of 75 to 100 deg. C. (water being added if necessary) in order to prevent the burning of the bags and to deposit moisture; it is then reheated to 80 to 120 deg. C., so that it will pass through the bag house without the temperature dropping below the dew point. The temperature control is most important in these plants.

The bag house consists of 2 units, each of 20 compartments having 12 bags, that is, a total of 480 bags. Each of these 12-bag compartments in each unit is automatically shaken hourly to remove the dust, and during this time the current of gas is reversed in order to blow the dust from the pores of the bags. The gas, on leaving the bag house, contains on an average 0.025 grm. of dust per cub. m., and is used in this condition for stoves, boilers, etc. A portion of the gas which is required for gas engines is further cleaned in a water-spraying tower and dried in a tower packed with wooden grids. The dust content of the gas for the engines is about 0.004 grm. per cub. m. Particulars given in an appendix show that the bag renewals amount to 10 to 15 per week, and that the power consumed averages

TABLE I.—*Plant VIII.—Lodge-Cottrell Plant (Plate Type)*

Date.	Gas temp.		Dust in gas.		Percentage of calcined ore used in blast furnace.
	Dirty gas. Deg. C.	Clean gas. Deg. C.	Dirty gas. Grm. per cub. m.	Clean gas. Grm. per cub. m.	
1927.					
Oct. 5 to 14 Average	214.6	130.6	5.23	0.42	58.3
Nov. 16 to Dec. 8 Average	173.2	95.7	4.10	0.17	41.7
1928.					
Jan. 4 to 10 Average	226.7	101.0	6.64	0.61	75.0

During the whole of the period only four of the electrical machines were in operation.

0.075 to 0.085 unit per 1,000 cub. ft. of gas cleaned. On a three-month period when the plant was operating normally, the following figures per 1,000 cub. ft. of gas cleaned were obtained:—Total wages, 0.0287d.; bags, 0.0072d.; stores and repair materials, 0.0046d. The all-in cost of running the plant, omitting depreciation and establishment charges, was 0.0778d. per 1,000 cub. ft. of gas. The capital cost of this plant at to-day's prices is approximately £23,000.

X.—Halberg-Beth Plant.—This plant, designed to clean 4½ million cub. ft. of gas per hour, is composed of four separate units, each consisting of ten double compartments containing 12 bags in each part, that is, 240 bags per unit, making a total of 960 bags. It is equipped with five Green economisers for controlling the gas temperature, to prevent either the burning of the bags or the deposition of moisture during filtration. Only one blast furnace was operating at these works at the time that the gas-cleaning tests were made, so that only two units were in service. The hourly treatment of gas was estimated to be 1,800,000 cub. ft.

The whole of the gas cleaned is only required for burning under stoves and boilers, consequently there was no necessity to install the final spray washer and dryer, as in the case of the last plant described. The comparison of the cleaning results must therefore be made on the dust content when the gas leaves the bag house. It was stated that one object of this plant when installed was the recovery of potash from flue dust, but at present this is not being carried out. The dust content of the gas on entering the plant, as obtained over a series of tests for four or five weeks (details of which are given by the author in an appendix), appears very variable, but is generally of the order of 5 grm. per cub. m., and the cleaned gas on leaving contains from 0.1 to 0.2 grm. per cub. m., although some tests show a much higher figure. These results do not compare very favourably with the previous plant figures, but it must be borne in mind that this gas is only required for burning purposes. In the previous case some of the gas is used in gas engines, and the bag filtration must reduce the dust content as far as possible to enable the final sprayer to lower it sufficiently for that purpose. In this plant the life of the bags is considerably longer than in the previous one; under the conditions at this works it is more economical to get a longer life from the bags even at the expense of a somewhat less efficient cleaning of the gas. The power expended in this plant amounts to 0.11 unit per 1,000 cub. ft. of gas cleaned, labour costs to 0.032d., and repairs, renewals, etc., including bags, to 0.0034d. The total cost of cleaning per 1,000 cub. ft. is 0.0603d.

XI.—Kling Weidlein Cleaner.—This type of cleaner, which depends upon the gas being passed by its own pressure through chambers in which are fixed wire-wool mattresses, has been introduced into some works in this country from America, but generally they have not been a success. Their object is only to give a gas suitable for burning in stoves and boilers; they are very cheap to operate as regards both power and labour, and undoubtedly serve to remove a considerable portion of the dust without losing the sensible heat of the gas.

This plant, which consists of five chambers, was one of the earliest erected outside of America, and was designed to clean 3½ million cub. ft. per hr. It is generally considered that the plant was rather too small to deal with that quantity of gas, and in the later designs more chambers have been added for plants of this capacity. The gas contained about 6 grm. of dust per cub. m. on entering the plant, and though numerous experiments were carried out, varying both the thickness of the mats and the coarseness of the wire-wool, it was not found possible to reduce the dust content regularly below 2 to 3 grm. per cub. m. Considerable mechanical difficulties were also met with, such as the breaking of the yokes during the periodical automatic shaking to clean the mattresses. By the time the mattress has become sufficiently clogged with dust to form a satisfactory filter, trouble is liable to arise on account of back pressure. In a series of nine tests carried out in 1923 the average of dust content of dirty gas was 6.85 and of clean gas 3.34 grm. per cub. m. The plant has not been in operation since the middle of 1925.

XII.—Kling Weidlein Cleaner.—This plant, consisting of a ten-compartment plant, is dealing with 3,200,000 cub. ft. per hr., each chamber being automatically cut off and shaken every two minutes. It appears to be the most successful one in this country, and although the dust content in the clean gas is not as low as is desired, the upkeep and the cost of the cleaning are very low. The conditions of temperature under which this type of cleaner operates are most important. If the temperature of the gas becomes too high there is considerable destruction of the wire mattresses, and if, on the other hand, it drops low enough to deposit moisture, the wet dust sets in the mattresses, and the chambers are put out of action. The gas temperature is therefore kept at about 150 to 200 deg. C. In this particular plant the cleaner is so situated as to meet these conditions best, and consequently more satisfactory results have been obtained than at other works. The average dust content of the crude gas is 7 grm. per cub. m., and it is cleaned down to an average of 1.8 grm. The power requirements are 0.003 unit, labour 0.004d., repairs 0.001d., wool and stores 0.0005d. per 1,000 cub. ft. of gas cleaned; the total direct cost of cleaning is 0.019d. for this amount of gas. The capital cost of this plant was given as about £20,000 at to-day's prices.

Two other plants of this type were visited, but it was found impossible to obtain results, as they had not been maintained in good working condition. In neither case could satisfactory results be obtained, even by using varying grades and thicknesses of the wire-wool, and at the present time the gas is being passed through to remove such dust as the mattresses are capable of retaining; no records are being kept, nor would it be fair to carry out tests on the apparatus as at present working.

From the results obtained from the four plants of this type, this cleaner hardly appears suitable for working under the conditions in this country.

Possible Developments.

There are two other types of apparatus which may be of interest, although no full-scale tests have yet been carried out on blast-furnace gas. The first is a new type of primary cleaner known as the Grant-Jones cleaner. It is in some respects similar to the Kling Weidlein apparatus, in that it is essentially a primary cleaner for supplying stoves and boilers, that the gas is filtered hot through a special material, and that the sensible heat of the gas is retained. In this apparatus the filtering medium is ground flint, which is evenly distributed over a travelling belt in two layers, coarse and fine; the belt of woven wire completely separates the upper half of the chamber, into which the crude gas is brought, from the lower half, so that all dust is drawn through the filtering bed. The flint with the dust is discharged by the endless travelling belt after its passage through the machine, and is then sieved free of the dust, regraded and automatically returned into the system. A small experimental plant was tried in the Midlands, and a larger plant is now being tried out at works in Leicestershire. A preliminary run has been made, but it is considered too early to do more than draw attention to what may develop into a valuable method of primary cleaning. The capital cost should be moderate, and there appears no reason to anticipate high operating costs.

The second type of cleaner has only been tried out on a blast-furnace plant in one small-scale experimental plant, where the conditions did not sufficiently resemble those required for satisfactory working for any reliable data to be obtained. It is of the cyclone type, which, as is well known, has been tried in very many different forms without any great success. This one, however, has been evolved after many years of experiment, and differs essentially from the ordinary types; it has given very satisfactory results in the removal of zinc dust in zinc smelting works, where a great number have been working efficiently for many years. The great attraction for a cleaner of this type is the extremely low capital cost of the plant, as it is believed by the inventor that satisfactory cleaning with this plant can be done with an outlay of hundreds of pounds instead of the thousands spent on the usual types of cleaners.

Comparison of the Results Obtained.

In Table II are tabulated the results obtained from the plants described above, from which it is possible to obtain a general comparison of the different types of plants from different aspects.

In the following comparisons the results obtained at Plant I must not be included, as this plant is treating only a small volume of gas for engine purposes. Plant IX (Halberg-Beth) may, however, be fairly compared, as only a portion of the gas is being finally washed for engine purposes, and the additional cost of this washing is comparatively small.

In the author's opinion the results obtained by the Kling Weidlein plants show that this type of machine does not give even a reasonably clean gas for stoves and boilers, and that to obtain satisfactory results it must be worked in conjunction with a subsidiary cleaning plant. In the present comparisons of working costs, therefore, this type of cleaner is disregarded.

(*a*) *Comparative Cleaning Powers.*—From the above tests it appears that the best results can be obtained by Halberg-Beth plants and by washing plants composed of spray tower and Theisen disintegrators, and that wet cleaners with spray towers only and the electrostatic cleaners are capable of cleaning down the gas to about 0.4 to 0.5 grm. per cub. m. The advantages obtained by burning gas cleaned to 0.4 or 0.5 grm. are very great compared with uncleaned gas, but there is a considerable difference of opinion whether this is sufficient to give the best results for water-tube boilers and similar purposes.

The exact point to which cleaning the gas for stove and boiler purposes can be economically carried (that is, to obtain the maximum heat development and minimum cost in refractories and repairs in relation to the cost of cleaning) is still an open question, but general considerations seem to indicate that a gas containing not more than 0.2 grm. per cub. m. gives sufficiently good results, and it is doubtful if further expenditure to decrease the dust below this is worth the extra cost.

(*b*) *Power Consumption.*—In this respect the best results are obtained by the electrostatic plants, of which the "pipe treater" gives the lower figure. The latter plant is, however, working 50 per cent. over capacity and yielding a rather less clean gas. If working to the capacity for which it is designed and assuming the same power were used, the figure would be 0.02 unit per 1,000 cub. ft. of gas. The Brassert tower and spray cleaner is next in order, the Halberg-Beth plants and Zschocke fan plant come next, and the most costly in respect to power are the combined tower and Theisen disintegrator plants.

(*c*) *Labour Costs.*—These are somewhat difficult to compare with any degree of accuracy, as they depend very considerably on the quantity of gas passing, as, provided no additional plant is put into operation for increased gas cleaning, the same labour can operate the plant for larger quantities of gas. For this reason the cost of labour in pence per hour, irrespective of the quantity of gas cleaned, is given in column 12 in

TABLE II.—*Comparison of Blast-Furnace Gas Cleaners.*

1 Plant No.	2 Type of plant.	3 Approx. capital cost at to-day's prices. £ per million cub. ft. capacity.	4 Capacity of plant. Cub. ft. per hour.	5 Gas cleaned per hour at N.T.P. Cub. ft.	6 Av. dust in crude gas. Grm. per cub. m.	7 Av. dust in clean gas. Grm. per cub. m.	8 Electric power. Units per 1,000 cub. ft. of gas.	9 Water. Gals. per 1,000 cub. ft. of gas.	10 Labour. Pence per 1,000 cub. ft. of gas.	11 Repairs, stores, etc. Pence per 1,000 cub. ft. of gas.	12 Direct labour. Pence per hour.	13 Operating costs. Pence per 1,000 cub. ft. of gas*.	14 Remarks.
I.	Spray tower, Jenkin fan, and Theisen washer.	Not available	600,000	600,000	4 to 5	0.02	0.275	30	0.0406	0.0105	—	—	—
II.	Zschocke tower, Zschocke fan or Theisen disintegrator	Do.	800,000	1,250,000	4 to 5	0.25 with Zschocke 0.02 with disintegrator	0.08 0.13	11½ 13½	0.0245	0.0040	30.62	0.0685 Zschocke fan 0.0935 Theisen	—
III.	Scrubbers and Theisen disintegrators	Do.	Over 5,000,000	Over 5,000,000	2 to 3	0.03 to 0.04	0.218	5.4 circulated 0.6 make up	0.006	Negligible at present	30.0	0.115	New plant, Dorr thickener and water recirculated
IV.	Brassert tower and Theisen disintegrator	7,000	2,500,000	Just over 2,000,000	6	0.15 to 0.20	0.15	55	0.024	Negligible at present	48.0	0.099	New plant
V.	Brassert tower and sprayers	5,000	5,000,000	2,750,000	5 to 6	0.40 to 0.50	0.029	29 to 37 1½—2 make-up water	Nil. None extra employed	Negligible at present	Nil	0.013	New plant. Dorr thickener and water recirculated. Only working half plant
VI.	Lodge-Cottrell (pipe type)	15,000	2,000,000	3,000,000	5 to 6	0.40 to 0.60	0.013	—	0.0181	0.0023	54.3	0.0269	—
VII.	Lodge-Cottrell (plate type)	10,000	2,000,000	2,000,000	5	0.40	0.025	—	0.014	0.0025	28.0	0.0290	—
VIII.	Lodge-Cottrell (plate type)	9,000	6,000,000	3,250,000	4 to 6	0.30	0.0225	—	0.0063	Not available under present conditions	22.47	0.0180†	4 electrical machines working out of 6
IX.	Halberg-Beth	11,500	2,000,000	2,000,000	3 to 4	0.025 0.004 after final spray for engines	0.08	Very little, only portion of gas washed	0.0287	0.0118, including bags	56.4	0.0661	—
X.	Halberg-Beth	Not available	4,750,000	1,800,000	5	0.1 to 0.2	0.11	Nil	0.032	0.0034 including bags	59.6	0.0904	Only half plant working
XI.	Kling Weidlein	Do.	3,500,000	3,500,000	6	2 to 3	—	—	—	—	—	—	—
XII.	Kling Weidlein	6,000	3,500,000	3,200,000	7	2	0.003	—	0.004	0.0015	—	—	—

* Based on power at ½d. per unit. † Labour, power, and stores only; no maintenance or renewals.

Table II; for comparison purposes it seems that these figures and those in column 10 should be considered together. They show that the labour costs on the Halberg-Beth plant are highest, but that in the other cases there is probably very little difference in this respect. Plant V must be regarded as exceptional, as the plant has been so arranged that all the labour involved is carried out by men employed on other work. Actually a portion of these men's wages should be allocated to the gas-cleaning plant, but no figures could be obtained on this basis.

(*d*) *Repairs, Stores, and Renewals.*—This item will depend to a very considerable extent upon the length of time the plant has been in operation, and the figures obtained under this heading are not strictly comparable. Plants III, IV, and V have all been recently started up, and the wear and tear is consequently very slight. The most costly plant in this respect appears to be the Halberg-Beth, especially when being operated to reduce the dust to a minimum as in Plant IX. The difference between Plants IX and X is to a great extent due to the longer life of the bags in the latter, owing to the higher dust content permissible in the cleaned gas. There is not sufficient evidence regarding other plants to indicate any definite superiority in this respect.

(*e*) *Working Costs.*—In order to obtain some comparison of the working cost of these plants, an arbitrary figure for power at ½d. per unit has been taken, and the total cost for power, labour, repairs, and renewals computed on this basis. In the majority of cases power is probably being obtained at a lower figure than ½d., but this has been chosen as a reasonable basis for comparison. The figures for the nine plants under discussion are given in column 13 of Table II.

In this comparison no charge has been made for the water used in washing, as in most cases this is obtained for the cost of pumping (included in power figure), and in others where water is not so available Dorr thickeners have been installed, which reduce the water make-up requirements to a very low figure.

From the above figures it appears that, on the whole, the electrostatic plant comes out most favourably. The Brassert tower and spray plant shows actually the lowest figure, but as already stated, no labour is allocated to the plant, and no maintenance has yet been necessary. These figures certainly would be very low under ordinary conditions, and such a plant would no doubt compare favourably with the electrostatic apparatus. The Halberg-Beth costs are clearly very much dependent on the state of cleanliness aimed at, as reflected by the bag renewals, but if worked to full efficiency the cost of operating seems to be about the same as those of the combined tower and disintegrator plants.

(*f*) *Capital Cost of Plants.*—It has been extremely difficult to obtain figures for capital cost of plants, as in some cases where the plants have been of composite design different parts have been added at different times; in other cases plants have been installed when prices were inflated during the post-war period, and actual figures under those conditions would be only misleading. In column 3 of Table II are given the capital cost figures per million cub. ft. capacity for those plants for which it has been possible to calculate them at approximately present-day prices. Although the "capacity" of plants is a somewhat elastic figure, especially in the case of wet cleaning plants, this appears to be the most satisfactory basis to adopt for comparison. From these figures it appears that the plants for which the information has been obtained come in the following order, the most expensive being the electrostatic (pipe treater) followed by the Halberg-Beth, the electrostatic (plate treater), and washing towers and disintegrators, the least expensive being washing towers with sprays, even when the cost of the Dorr clarifier is included.

THE ADDRESS of A. C. M. Furnaces, Limited, is now Mazda Buildings, Campo Lane, Sheffield.

IN ORDER TO AVOID CONFUSION with other firms similarly designated, the name of the Eagle Foundry Company, of Tipton, is to be changed to the Revo Foundry Company.

British Facilities for Foundry Training.

No. III.—COUNTY TECHNICAL COLLEGE, WEDNESBURY (Staffordshire Education Committee).

By Percy Fox-Allin, Associate Editor of the "Foundry Trade Journal."

The present principal of the County Technical College is Mr. T. G. Bamford, M.Sc. These notes were, however, written whilst the College was still under the direction of Dr. Douglas H. Ingall, who has now taken up his new appointment in Middlesbrough.

Prior to Dr. Ingall's departure the writer had the good fortune of discussing with him the problem of the higher education of the future foundryman. Dr. Ingall has very pronounced views upon the necessity of such higher education, and is also sensible of the very limited nature of the facilities at present existing for the scientific and practical training of the student.

Dr. Ingall's Views.

If Dr. Ingall's suggestions could but be carried out in their entirety they would ensure a supply of men capable of upholding and extending the best traditions of the founding industry.

Briefly Dr. Ingall referred to the shortage of really high skilled moulders, and rightly pointed out that moulders could not be made in the technical school. His suggestion was that each foundry in a particular district should select two or three boys who would spend two evenings a week at the technical school, and that the class composed of those boys would spend one-half day a week in a local foundry, a portion of the foundry floor being laid off for the class for the half day, and the boys to work under a skilled artisan.

The foundry for the practical work would be changed every three months so as to give the students as wide a scope as possible. This form of training would be continued for, say, two years. During this period the boys would automatically select themselves, as it were, by failing in exams. or showing lack of the necessary application, but the select few of the group would then spend from two to three years training in the technical school or college. To render this final period of the most useful benefit it would be necessary to provide an experimental foundry at the school or college so that whilst studying the purely scientific side of their prospective industry they would also be able to acquire a practical knowledge of the less understood side of foundry practice, such, for example, as pearlitic iron castings, castings in alloy irons, semi-steel, etc.

Dr. Ingall's, as indeed must be every suggestion which aims at a complete solution of our problem, is wholly dependent upon the amount of practical sympathy which the industry is prepared to extend to it.

An argument which the writer has heard put forward against the suggestions of Dr. Ingall is: What guarantee has the owner of the foundry who has assisted in the education of the student that he will retain his services when his course is completed. Such an argument is futile, there is obviously no such guarantee. The student will naturally throw in his lot where his services are best financially recognised, but foundries are not philanthropic institutions, and it is quite certain that the erstwhile student will be paid for no more than the weight he pulls; and, indeed, if we are to develop the higher grade of foundryman we must show the embryo student that brains are a marketable commodity in the foundry.

For the time being the workshops and laboratories at the County Technical College are in a state of transition. The laboratories in connection with the metallurgical department were somewhat disconnected, and the extensions to the college buildings which are at present in progress gave Dr. Ingall the opportunity he desired conveniently to group the various laboratories and engineering department.

Unfortunately there is very little to be said of the foundry, which is situate in a small room in the basement, with the pattern shop in an adjoining room. The melting plant consists of an air-furnace, from which casts up to 60 lbs. can be made.

The engineering shop is very well laid out for a varied course of instruction. There is a 16-h.p. Crossley gas engine, which is provided with rope brake for testing purposes; when the re-arrangement has been completed this engine will serve to drive the works generator. Other special apparatus include: Orifice tank for hydraulics, apparatus for testing friction of water in pipes, apparatus for testing water jet on Pelton wheel, as also apparatus for measuring re-action of water jet; apparatus to demonstrate the effect of pressure on temperature of saturated steam; small pumping set and condenser, and in an annexe a gas-fired vertical boiler for working pressure of 80 lbs., and a range of up-to-date machine tools complete the equipment.

The physical test house contains an Olsen 30,000 lbs. machine; beam testing appliance for measuring deflection of beams under load; Curson's apparatus for determining creeping load of struts, etc. An interesting apparatus has been built at the college for measuring the pull of electric magnets at various currents.

The metallurgical laboratory has the usual equipment and three fume chambers. The balance room adjoins; the whole of the balances are swung clear of the floor, and are thus unaffected by vibration, an important consideration in a manufacturing district; each balance is independently lighted. The metallograph room is equipped for vice work, dry and wet polishing, benches for etching and microscopical work; each instrument is separately lighted.

In the photo micrography room is a Reichert apparatus, etc. As previously stated, the metallurgical department is at the moment in a state of transition. The new buildings which are in course of erection are primarily designed for instruction on engineering production, and when completed the equipment will include a number of up-to-date machine tools. There will be a testing laboratory, in which provision is made for a 50-ton Universal testing machine, Izod Impact testing machine, Brinell hardness and small-ball Brinell, and also wire-testing machinery. A heat-engine house, where both gas and steam engines will be put down, as also motor generator set and motor testing set, etc.

The re-arrangement of this section of the college will relieve the congestion in the metallurgical section and permit of this last being conveniently grouped, as also much needed additions being made by way of electric heat treatment, melting furnace and experimental furnaces laboratories. Two research laboratories are provided, and there is also the nucleus of an excellent library. The new arrangement of the laboratories will permit of more perfect co-ordination between the engineering and the metallurgical sections. Dr. Ingall's scheme provides for the student casting his own metal and taking that metal throughout the various processes of heat treatment, testing, polishing, etching, microscopical examination and micrography.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their "Statistical Bulletin" for May, state that the production of pig-iron in May amounted to 591,500 tons, compared with 563,100 tons in April and 720,100 tons in May, 1927. There was thus a slight increase in the daily rate, which rose from 18,770 tons to 19,081 tons. The furnaces in operation at the end of the month numbered 148, a net decrease of one on the numbers in blast at the beginning of the month. The output of steel ingots and castings in May amounted to 752,700 tons, an increase of 108,600 tons compared with April, when output was below normal on account of the Easter holidays.

Returns from 132 firms employing 83,865 workpeople at the end of May showed a decrease of 839 compared with April and a decrease of 10,052 compared with May, 1927.

Sir Robert Hadfield, Bt., F.R.S., on the Paper "Steel Castings for Severe Service."*

Introduction.

I have read Mr. J. H. Hall's Paper on "Steel Castings for Severe Service," and congratulate him on this interesting contribution. As one of your honorary members, a privilege I esteem most highly, I was appealed to by your Past-President to send a few comments on the Paper, which I have pleasure in now doing, and hope these will be of interest, specially in relation to the references made by Mr. Hall on the subject of manganese steel.

I would like to take this opportunity of expressing my thanks to Mr. Hall's Company, and my friends of long standing—Messrs. The Taylor Wharton Company—for the great interest and help they rendered, now many years ago, in the development of my manganese steel in the United States. In this they were assisted by my friend, the late Professor H. M. Howe, whose work, "The Metallurgy of Steel," published in 1890, dedicated as it was to Sir Lowthian Bell, was of such great assistance to us all in the earlier days of modern metallurgy (1870-1900).

It is now some forty years ago since I invented this special steel and its treatment, and my metallurgical friends have been kind enough to say

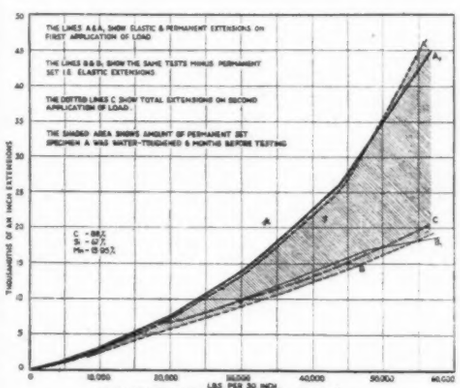

THE LINES A & A, SHOW ELASTIC & PERMANENT EXTENSIONS ON FIRST APPLICATION OF LOAD
THE LINES B & B, SHOW THE SAME TESTS MINUS PERMANENT SET I.E. ELASTIC EXTENSIONS
THE DOTTED LINES C SHOW TOTAL EXTENSIONS ON SECOND APPLICATION OF LOAD
THE SHADED AREA SHOWS AMOUNT OF PERMANENT SET
SPECIMEN A WAS WATER-TOUGHENED 6 MONTHS BEFORE TESTING
C - .88%
Si - .42%
Mn - 13.93%
THOUSANDTHS OF AN INCH EXTENSIONS
LBS PER SQ INCH
MANGANESE - STEEL UNDER TENSILE - STRESS (2 SPECIMENS)
DATA FURNISHED BY PROF KENNEDY (NOW SIR ALEXANDER KENNEDY)

FIG. 1.

this steel was the origin of the present age of alloy steels, opening up, as it did, the vista of the many other wonderful combinations of iron which followed and are obtainable by the use of various elements added to iron.

I am glad to find the author from his wide experience and in his statements fully confirms that manganese steel has more than fulfilled the expectations I formed at the time of its discovery, in regard to its probable utility and importance; also that, as now shown by its ever-increasing use, very great benefit has been derived by its users throughout the world.

It will probably be of interest to those who may happen to read these remarks to know that manganese steel, including its heat-treatment, is to-day exactly the same type of material which I invented about 1882, that is, there have been no changes or alterations in composition or general methods of manufacture.

Before writing these notes I took the opportunity of looking over my original and exhaustive Papers on manganese steel, read in 1888 before the Institution of Civil Engineers and the Iron and Steel Institute, and may add that with hardly an exception I cannot see anything of importance to alter or change, whether as regards my original experimental work or the conclusions at which I then arrived, thus showing that my invention was indeed a basic one and founded on correct scientific and practical principles. The recognition of the value of this invention by so many bodies and societies, scientific and technical, and by the many honours they have been kind enough to bestow upon me in my own country, America, France, and elsewhere, has naturally afforded me the highest satisfaction. Not the least is that bestowed by the Institute of British Foundrymen when in 1914 you elected me one of your honorary members.

In the Paper now under discussion Mr. Hall describes in an interesting manner a number of facts about manganese steel, all of them known long ago in this country, and therefore it is hardly necessary to deal with some of his remarks as they do not represent anything new to us in England, the home of the invention of this steel. I beg, however, to make the following comments, which I trust will be of general interest.

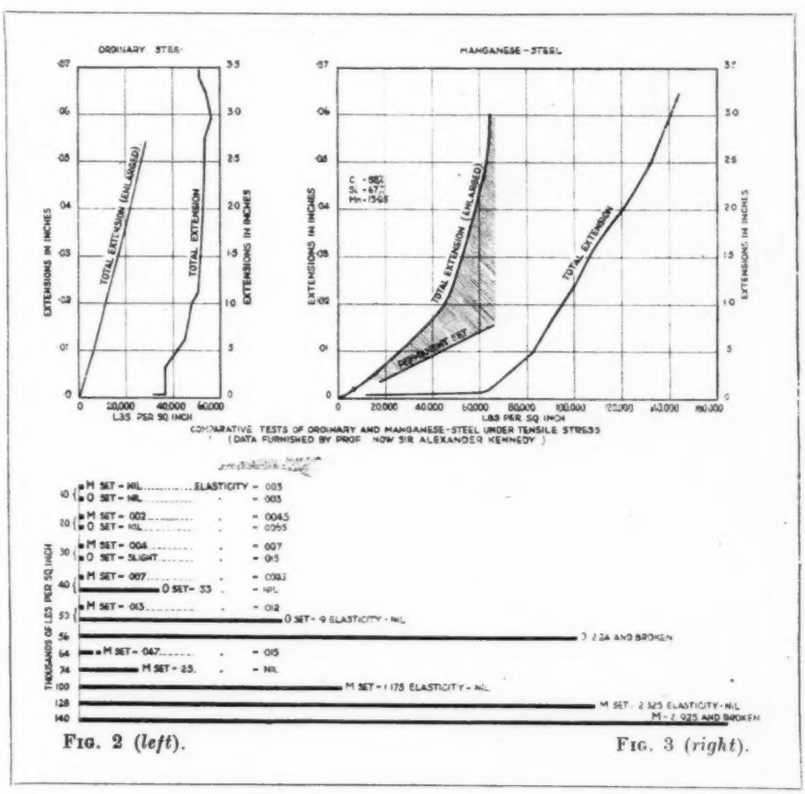

ORDINARY STEEL
MANGANESE - STEEL
TOTAL EXTENSION (UNLOADED)
TOTAL EXTENSION
PERMANENT SET
EXTENSIONS IN INCHES
LBS PER SQ INCH
COMPARATIVE TESTS OF ORDINARY AND MANGANESE-STEEL UNDER TENSILE STRESS
(DATA FURNISHED BY PROF NOW SIR ALEXANDER KENNEDY)
M SET - NIL ELASTICITY - 005
O SET - NIL - 003
M SET - 002 - 0045
O SET - NIL - 0055
M SET - 004 - 007
O SET - SLIGHT - 05
M SET - 007 - 0133
O SET - 33 - NIL
M SET - 013 - 012
O SET - 9 ELASTICITY - NIL
2 22A AND BROKEN
M SET - 047 - 015
M SET - 23. - NIL
M SET - 1175 ELASTICITY - NIL
M SET - 2 525 ELASTICITY - NIL
M - 2 925 AND BROKEN
THOUSANDS OF LBS PER SQ INCH

FIG. 2 (*left*). FIG. 3 (*right*).

Work-Hardening Qualities of Manganese Steel.

Mr. Hall presents certain explanations as to the work-hardening nature of manganese steel in service, and states that these were not known, defined, or understood until some fifteen or twenty years ago. It is quite true that there has been in the past much misconception prevalent regarding this point by those who had not studied or were not fully conversant with the subject. In this respect I may, however, remind him that in addition to having noticed these facts, my intimate friend, the last Professor Floris Osmond, the famous French metallurgist, accurately described and explained, some thirty-five years ago, the qualities which the author now mentions as not having been known until comparatively recent times.

With regard to what may be termed the work-hardening qualities of manganese steel, that is, as produced by working or pressure at ordinary atmospheric temperatures, during the discussion on the Report of the Hardness Tests Research Committee of the Institution of Mechanical Engineers in November, 1916, I gave a full description and explanation of these most peculiar qualities, also of its valuable behaviour in this respect. A full and adequate reply as to why these remarkable changes occur is still not clear, and leaves room for further research. In this respect, research, and still research, is ever the motto of the metallurgist.

Elastic Limit and Yield Point of Manganese Steel.

With reference to the statement by the author regarding the elastic limit of manganese steel, namely, 17.8 to 20 tons per sq. in., I presume that when he refers to this he really means yield point, as the true elastic limit is much lower and not easily determined. If yield point is meant, I consider his figures somewhat too low. Data on this point were quoted in my original Paper already mentioned, when I showed that a tensile bar of manganese steel possessed a yield point of the order of 24 or 25 tons per sq. in. In compression the yield points are somewhat higher, being of the order of 35 tons per sq. in.

In relation to mechanical qualities, I refer the author, also any other inquirers on this point, to pages 52 to 55 in my original Papers already mentioned, and published in 1888, also to the interesting diagrams there shown in Plate 2, Figs. 4, 5 and 6, shown herein as Figs. 1, 2 and 3, which were prepared for me at that time by the kindness of Professor, now Sir Alexander Kennedy, F.R.S., who was then Professor of Engineering of University College, London. By the kind permission of the Institution of Civil Engineers I am allowed to present these, as they will no doubt be of interest to those who read these present notes of mine.

The two Papers in question described the numerous compositions produced in my research, including the one now known throughout the world as the Hadfield manganese steel. They also described the method I invented of obtaining the wonderful toughness noticed in manganese steel; that is, by heating to a high temperature, about 850 deg. to 1,050 deg. C., and quenching preferably in cold water or other suitable cooling medium.

Manganese steel in its natural "cast" condition is not at all tough, but extraordinary tough-

* A written contribution to the discussion on a Paper presented by Mr. J. H. Hall to the Annual Meeting of the Institute of British Foundrymen.

ness is obtained, as evidenced by tensile testbars whether from cast or forged materials. In the forged and toughened condition, a tenacity of between 60 and 65 tons tenacity per sq. in. is obtained, and elongation on 8-in. lengths of no less than 50 to 60 per cent., in some cases over 70 per cent.

It will be seen that this result is exactly the reverse of that obtained with carbon steel. By heating carbon steel, even to a much lower temperature and quenching in cold water, as everyone knows, the resultant product is exceedingly hard and brittle. For medium and high-carbon steel the Brinell ball-hardness is of the order of 550 to 700.

During the discussion (1888) which took place on my Papers, **Sir Alexander Kennedy gave a** long, interesting and full account of the tests he had carried out, including the determination of the modulus of elasticity. The diagrams prepared by him for me are so interesting that I reproduce them from the original Paper by the kind permission of the Institution of Civil Engineers. Repeat tests now made give the same results, showing how satisfactory was the original composition determined so long ago.

Figure 1 shows the stress-strain diagram for two specimens of manganese steel (C 0.88 per cent., Si 0.67 per cent., Mn 13.95 per cent.) under tensile test. The curves A. and A.1. represent the total extension of the two specimens on the first application of load; that is, the sum of elastic and permanent extension. The lines B. and B.1 indicate the elastic extension only. The shaded area, therefore indicates the amount of permanent set, and the dotted lines C. show the total extensions on the second application of the load.

The specimen bar A. was toughened by water-quenching about six months before the actual testing took place, this being done in order to ascertain whether secular changes might have occurred. The specimen A.1. was toughened shortly before testing.

Fig. 2 is a stress-strain diagram for ordinary steel. It shows the total extension on two scales, that on the left being fifty times greater than for the diagram on the right, which was continued until rupture occurred.

Fig. 3 shows comparative stress-strain diagram for manganese steel on the same scales, that is, the total elongation is shown enlarged on the left and at a scale fifty times smaller on the right, where it is continued until fracture of the specimen.

These two interesting diagrams, Figs. 2 and 3, permit comparison side by side of the elastic set of ordinary and manganese steels.

Sir Alexander Kennedy.

It is interesting to note that Sir Alexander, who rendered much help to me by making these original tests and other investigations on the mechanical qualities of manganese steel, although now over 81 years of age, is happily and most actively still with us. He has been President of both the Institution of Civil Engineers and the Institution of Mechanical Engineers. By his sound engineering work and practice exercised over a long period of time he has indeed set a striking example to all of us.

I am glad to tell our members that only the other day I had the pleasure of meeting Sir Alexander, hale and hearty, on the golf links at Tandridge, in connection with the meeting of the Engineering Golfing Society. Although he does not now play "the great game," he is still as much interested as ever in the performance of his brother engineers, and many years ago presented the prize known as the Kennedy Cup, for which there is an annual competition.

May he long remain with us to help on the profession of engineering, which has assisted so much in the world's progress during the last hundred years, and the Centenary of which, namely, that of the Institution of Civil Engineers, a Body now over 10,000 strong, was celebrated with such success only a few weeks ago. At this Conference, Sir Alexander assisted in the proceedings, and presided over one of the sections.

Steel of Higher Manganese.

With reference to the type of steel mentioned by the author, of somewhat higher manganese than that usually present in ordinary carbon steels, from about 1.00 to 2.00 per cent., I may say in passing that my firm first made steel of similar composition as far back as February, 1894. Later on, practical applications of this composition were made and the material sold commercially, considerable quantities being produced in the years 1904 and onwards.

Heat-Treated Steel Castings.

I note that the author, Mr. Hall, describes heat-treated steel castings possessing high strength and toughness. He states that his company in America first put on the market in 1909 such steel castings. I congratulate him on his firm's enterprise in the field in question. I am sure, however, that our members on this side of the water will be glad to learn that my firm, Messrs. Hadfields, Limited, of Sheffield, produced at a time considerably before the date mentioned by the author large quantities of heat-treated alloy-steel castings of important nature. The Terre Noire Company had also done this at a still earlier period as regards carbon-steel castings, generally using oil for their toughening baths.

Unfortunately I cannot attend the meeting, to be held in Leicester, to present this information myself, but have much pleasure in sending copies of the photographs described below showing some of these Hadfield heat-treated steel castings, typical as they are of many other applications of similar products. They are, too, of interest as showing how *cast* products of steel can in many cases, and for certain classes of work, be made practically equal in toughness, soundness and other qualities as compared with forged steel, and at less expense.

Photograph Fig. 4 represents a *cast* ammunition tube, of "Era" steel, weighing 16 tons, made by Messrs. Hadfields, Limited, in their large steel foundry. This was supplied to His Majesty's Government in 1905, and tested a few months afterwards; the extraordinarily satisfactory results are well brought out by the photograph.

The other photograph, Fig. 5, shows a casting of "Era" steel in the form of a gun shield, weighing 10 tons, also supplied by the same firm to His Majesty's Government in 1908. The excellent manner in which this stood the severe tests shows the high quality of this cast material.

Such tests are probably the most severe to which steel, whether cast or forged, can be submitted, that is, the attack of gun fire. In the case of the ammunition tube, this heat-treated steel casting resisted the attack of 6-in., 7.5-in., and 9.2-in. armour-piercing projectiles fired at velocities up to 2,040 foot-seconds. In the case of round No. 4 at the tube in question, no less than 11,000 foot-tons of energy were expended at this one impact, and the total energy expended on this tube was 50,000 foot-tons.

As regards the gun shield, this successfully resisted the attack of 4.7-in. and 6-in. armour-piercing projectiles fired at velocities up to 2,050 foot-seconds. The striking energy in the case of one round was 2,928 foot-tons, which is equivalent

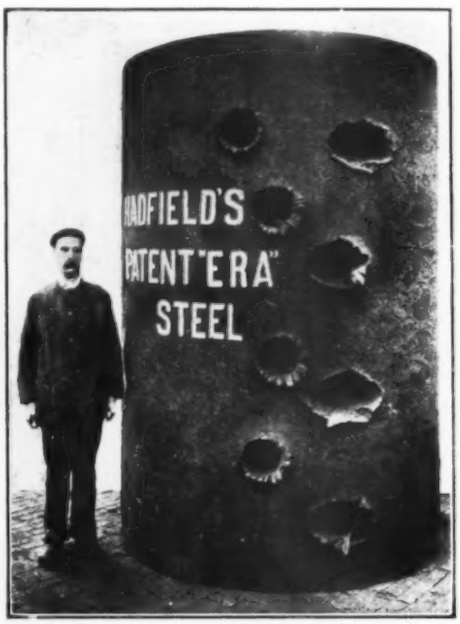


FIG. 4.—AMMUNITION TUBE OF THE HADFIELD "ERA" CAST STEEL.

This tube was attacked by common shell, semi-armour piercing shell, armour-piercing shot of 6-inch, 7.5-inch and 9.2-inch. calibres, and up to 2,040 F.S. striking velocity. In the case of one round 11,000 tons of energy was expended at one impact. Total energy expended on the tube was 50,000 foot tons. This tube is of Hadfield's "Era" steel cast to shape, and has been neither forged, rolled, pressed, nor stamped.

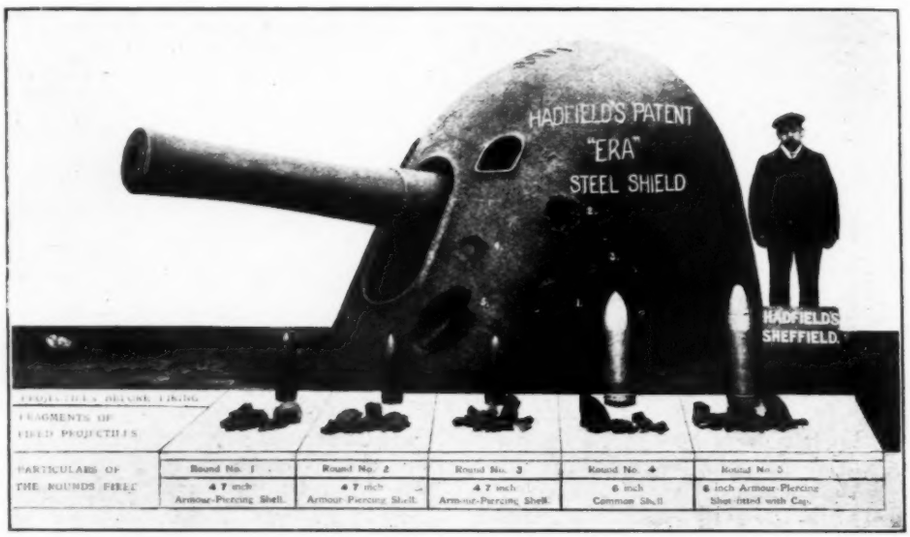


FIG. 5.—"ERA" CAST STEEL SHIELD (HADFIELD'S PATENT) FOR 6-IN. GUN MOUNTING AFTER FIRING TRIAL.

Five rounds, comprising 4.7-inch armour-piercing shell, 6-inch common shell and 6-inch armour-piercing shot, were fired against this shield, giving a total striking energy of 8,950 ft.-tons on an area of impact of only 13 square feet. Round 5040 (6-inch capped A.P. shot) represents a very severe test; the striking velocity was 2,050 f.s. and the striking energy 2,928 ft.-tons, which is equivalent to perforating 10½ inches of mild steel or 8 inches of Krupp hard-faced armour. It will be seen that very little damage was done to the shield, and that it would have offered full protection to the gun's crew and mounting.

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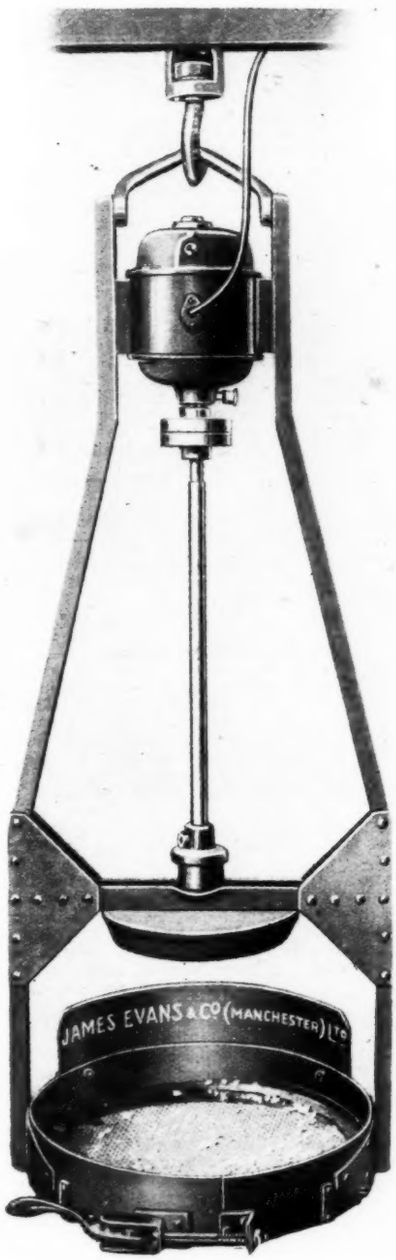

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to perforating 10½ in. of mild steel or 8 in. of hard-faced armour.

The yield point of such heat-treated nickel-chromium steel is from 30 to 35 tons per sq. in., and the tenacity 45 tons per sq. in.

Heat-Resisting Castings.

Reference is made by the author to heat-resisting castings. We in this country are not behind in this important advance. My own firm alone has already produced large tonnages of such products, including castings weighing up to more than three tons each. I gather from the author's remarks that he considers there is a reluctance in America to make castings of such nature. All I can say is that we over here will gladly execute contracts of almost any size for such classes of work. Moreover, so far, I have not seen many designs of castings submitted to us that we could not undertake, whether in the quality of steel known as heat-resisting or non-corroding.

Conclusion.

In conclusion, I wish our Society every success in the excellent work it is accomplishing in increasing our scientific and technical knowledge with regard to foundry work of all kinds, with the many metals and alloys which modern invention has placed at our disposal.

Trade Talk.

THE WORKS of the Fownes Forge and Engineering Company, Limited, East Moors, Cardiff, have been purchased as a going concern for £4,000 by Mr. Leonard Macarthy, of Newcastle.

THE BRIGHTSIDE FOUNDRY & ENGINEERING COMPANY, LIMITED, Sheffield, are to manufacture the simultaneous decking plant for the new shaft of Messrs. Locke & Company (Newland), Limited, Normanton.

IN THE COURSE of the past six months the Belfast shipyards launched 11 vessels, aggregating 61,720 tons, as compared with 10 vessels, aggregating 56,969 tons, during the first half of 1927. This is the highest total recorded for the first half of any year since 1923.

AN ORDER FOR four experimental locomotives has been awarded by the High Commissioner for India to the Vulcan Foundry, Limited, of Newton-le-Willows, Lancs. Contracts for 124 boilers for new standard-type locomotives for the Indian State Railways have been placed with Continental builders.

DURING THE FIRST six months of the current year Clyde shipyards launched 116 vessels, aggregating 304,174 tons, as compared with 95 of 145,160 tons in the corresponding period of last year. It is anticipated, however, that output during the second half of 1928 will be curtailed, as new orders are not being placed in sufficient numbers to make up for the work completed.

THE SOUTH AFRICAN RAILWAY BOARD has placed an order with Messrs. Beyer, Peacock & Company, Limited, Manchester, for two heavy articulated engines to cost £14,500 each. A contract for 36 smaller locomotives, amounting to £200,730, has been placed with a Swiss locomotive company, whose tender was nearly £1,000 per locomotive lower than the lowest British tender.

A NUMBER OF NEW CONTRACTS has been booked by Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited. They include a twin-screw steamer with triple-expansion propelling machinery for the Corporation of Trinity House; a 10,300-ton tank motor-ship for Messrs. John I. Jacobs & Company, Limited, London; a 11,000-ton tank motor-ship for Aktiebolaget Olson & Wright, of Stockholm, and 25 superheated locomotive boilers and six boiler shells for the Buenos Ayres and Pacific Railway Company.

AMONG RECENT CONTRACTS secured by the Mirrlees Watson Company, Limited, Glasgow, are a surface-condensing plant, 5,000 kw., for the Galashiels and Electric Power Company, Falkirk, and a surface-condensing plant, 5,000 kw., for the Galashiels and District Electric Supply Company, Limited, both to the order of Messrs. Balfour, Beatty & Company, Limited, London; a Mirrlees-Delas-Ginabat surface-condensing plant, 2,000 kw., for the Gondalpara Jute Mills, India; a 10-in. centrifugal pump for the Southend Corporation Sewage Department; and two borehole pumps and two booster pumps for the Ashby-de-la-Zouch Corporation.

AT THE ANNUAL conference of the Council of the National Union of Blastfurnacemen, at Blackpool, the general secretary, Mr. Thomas McKenna, said the pig-iron industry pre-war and up to 1920 employed 30,000 workpeople, 330 blast-furnaces operated and produced about 9,500,000 tons of pig-iron. To-day only 18,000 people were employed in the industry itself, 146 furnaces were in blast, and the production was 7,000,000 tons. He was of opinion that whilst they might get back to 9,000,000 tons production, the industry would never employ anything like the same number of workpeople again, nor would it operate more than 200 blast-furnaces. A marked transformation and a definite change had come over the industry since 1920. Making a comparison with pre-war years, the output per furnace had increased by 45 per cent.

THE DIRECTORS OF Messrs. Parkinson & W. & B. Cowan, Limited, in a circular to the shareholders, state that the business of the company has steadily increased during recent years, and they consider that in order to take full advantage of opportunities for development and expansion, which now present themselves, further working capital is required. They have decided to issue 50,000 of the unissued 7 per cent. cumulative preference shares of £1 each at 20s. 6d. per share and 100,000 of the unissued ordinary shares of £1 each at 24s. per share, and to offer these shares to the existing shareholders. Subscribers will have allotted for cash two ordinary for every one preference allotted, but no application for ordinary shares alone will be considered. It is stated that the audit for the year to March 31 last is not yet completed, but the directors anticipate that the profits will not be less than those of 1926-27, and that they will be able to recommend a final dividend on the ordinary shares of 7½ per cent., making 10 per cent. for the year.

AT THE first annual meeting of the members of the London Iron and Steel Exchange, held at the Exchange, Imrie House, King William Street, E.C.4, on Monday, July 2, Mr. James Whitby presiding, the following gentlemen were elected to serve on the Committee in the ensuing year:—Messrs. Herbert Ballard (Cargo Fleet Iron Company, Limited), Alfred H. Barnard (H. B. Barnard & Sons), F. Baxter (Baxter, Fell & Company), R. L. P. Bell (Barnes & Bell, Limited), W. Bishop (Guest, Keen & Nettlefolds, Limited), J. C. Blair (A. G. Kidston & Company). R. Booth (Whitehead Iron and Steel Company), H. E. Edwards (Steel, Peech & Tozer, Limited), Henry Gibbons (Gibbons, Skinner & Company), J. J. Goddard (Bowesfield Steel Company, Limited), J. P. Hempstead (Gollin & Company Proprietary, Limited), Robt. Pooley (Shelton Iron and Steel Company), H. J. Skelton (H. J. Skelton & Company, Limited), John H. Skelton (H. J. Skelton & Company, Limited), Watson Slack, Cyril Watts (South Wales Tinplate Corporation, Limited), and James Whitby (John Summers & Sons, Limited). The matter of the time to be regarded as "high change" was brought forward, and, after discussion, the meeting decided to maintain for a period the present time of 12.30 to 1 p.m.

THE PRINCE OF WALES visited the Clydebridge Steelworks of Messrs. David Colville & Sons, Limited, during his stay in Glasgow recently. He was received at the entrance to the works by Mr. John Craig, chairman of Messrs. Colville & Sons; Mr. G. P. West, director and general manager; and Major Piggott, of the firm's London office. Among those who were presented to the Prince were Mr. J. B. Allan, Mr. T. G. Hardie, Mr. John Lennox, Mr. A. I. H. Mowbray, and Major Colville, directors, Captain David Colville, and Mr. R. P. Smith, works manager. The Prince and his party made a round of the various departments under the direction of Mr. Smith. His Royal Highness displayed great interest in the various processes of steel-making. The process of charging several of the furnaces and the tapping of another furnace was witnessed. The party then passed on to the cogging mill, where the Prince asked that the process of controlling the mill should be explained to him. Similar interest was shown by the Prince when he passed into the rolling mill adjoining, and there he drew the lever which started the rolling of a plate for the new White Star liner which is about to be built at Belfast and which when completed will be the world's largest ship. This was a keel plate of 3½ tons in weight. In this department Mr. D. Fraser, assistant works manager, was presented to the Prince.

Contracts Open.

Warrington, July 14.—Castings, iron and steel; lead and compo pipe; railway materials; steel and cast mains; taps, valves, etc., for the Gas Committee. Mr. A. Cook, engineer and manager.

Leeds, July 14.—Supply and erection of approximately 1,300 tons of structural steelwork, for the City Council. Mr. C. Nelson Hefford, manager of the department, 1, Whitehall Road, Leeds. (Fee, £2 2s., returnable.)

Pontefract, July 24.—2,000 yards of 16-in. cast-iron pumping main, for the Corporation. Mr. F. Walter Hodson, Bank Chambers, Loughborough. (Fee, £5 5s., returnable.)

Personal Paragraphs.

MR. J. HAMILTON GIBSON has taken into partnership Mr. James Foster Petree, and will practise with him as from July 1, 1928, under the style of Hamilton Gibson & Petree, consulting engineers, at 3, Central Buildings, Westminster, S.W.1.

MR. ALEXANDER SUSMAN'S contract as general manager for the United Kingdom of the African Life Assurance Society has been determined as from June 21 by mutual consent. We understand that Mr. Susman will in the near future be undertaking an important position with an influential insurance group in the City of London.

MR. GEORGE H. NISBETT, J.P., has been elected managing director of British Insulated Cables, Limited, of Prescot, Lancs. Mr. Nisbett commenced his engineering career in 1883 with Messrs. Paterson & Cooper, later being contract manager to that firm. Afterwards he joined the City of London Company as chief electrical engineer and during his service with that Company he designed and laid down what was the first low-tension alternating distributor system in this country, and probably in the world. Another innovation for which he was responsible was the use of lead-covered cables for underground distribution on an appreciable scale. He joined the British Insulated Wire Company (now British Insulated Cables) in 1894 as chief engineer. He became chief engineer and manager in 1902, and was appointed a director in 1924.

Wills.

WALTON, C. E., of Nelson, iron and steel merchant	£13.884
LITTLEJOHN, G. J., Edinburgh, chairman of the Pather Iron and Steel Company, Limited, Wishaw	£16,255
WALMSLEY, R., of Southport, iron manufacturer and iron and steel merchant, of Thomas Walmsley & Sons, Bolton...	£109.257

Obituary.

MR. M. WARNER, of Messrs. French & Smith, metal brokers, of 11, Oldhall Street, Liverpool, died recently.

SIR DAVID YULE, Bt., who died last week at St. Albans, was a director of Messrs. Vickers, Limited. He was 70 years of age.

MR. GEORGE A. WILSON, a well-known figure in the North of England steel trade, has died at South Bank in his seventy-first year. Mr. Wilson was born in Motherwell, and after having had experience in Scottish steelworks, ultimately went to the works of the Frodingham Iron & Steel Company, Limited, where he was one of the first steelmakers to operate the Talbot basic open-hearth process. Later he became steelworks manager at the Britannia Works of Messrs. Dorman, Long & Company, Limited, and joined the Cargo Fleet Iron Company, Limited, in 1906, at the commencement of the new works, which had been built to operate the Talbot process. During the war he was awarded the M.B.E. for special services in connection with the manufacture of shell steel.

SIR JOHN ISAAC THORNYCROFT, who died recently at Bembridge, Isle of Wight, at the age of 85, was a pioneer in naval architecture, and particularly in the construction of small vessels of very high speed. He was the founder of the shipbuilding and engineering company of Chiswick and Southampton which bears his name. Born at Rome in 1843, he entered Palmer's shipbuilding yard on the Tyne as a draughtsman; and afterwards he went to Glasgow, where he had Lord Kelvin and Macquorn Rankine as his teachers at the University, and worked under John Elder. He was only 23 when he started his shipbuilding works on the Thames at Chiswick in 1866, but the improvements he effected in the construction of small craft for the Navy, and especially in the building of high-speed torpedo boats, eventually made his name known throughout the world. He was knighted in 1902. His scientific attainments were recognised by the Royal Society in the conferment of its Fellowship on him.

MEMBERS OF THE American Ceramic Society paid a visit to Birmingham and the Midlands recently. During their stay they were entertained by the Birmingham Chamber of Commerce and the North Staffordshire Ceramic Society, and works in the district were visited. It was announced that the British Ceramic Society will visit America next spring. Before coming to England the party inspected numerous plants associated with the brick-making, refractory materials, and cement industries on the Continent.

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VOLATILE	,, ,,	1 %
MOISTURE	under	1·50%

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Never, perhaps, in the long history of the Cleveland iron trade have conditions reached such a state of despondency as exists at present, and, although many slump experiences have overtaken the market in bygone times, not even the oldest member on 'Change can readily recall a parallel to the position as it now presents itself. Home consumptive demand, usually quiet in the mid-summer season, is much below the average owing to shortage of orders at the foundries, and consequently buying on this account is now restricted to almost retail proportions. Admittedly a number of small parcels are changing hands, but the total tonnage involved is quite small, and the inference is that either because of the industrial uncertainty or in the hope of lower prices—perhaps both—buyers are holding off the market as long as possible. On the export side the June shipments of pig-iron from the Tees, coastwise and foreign, only total 15,634 tons, which is the smallest monthly total since November last. Actually the coastwise shipments are up, reaching 10,012 tons in June, compared with 8,446 tons in May, but the foreign exports only amount to 5,622 tons, which is a mere bagatelle. Prices meantime remain firm and unchanged, as follow:—No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge iron, 64s. 6d. per ton.

The conditions above outlined in the case of foundry iron apply with equal force to the situation in the Tees-side hematite market, the business passing being practically negligible in volume and without the smallest margin of profit to producers. With regard to price, even for truck lots 69s. per ton is now a general quotation for mixed numbers, and 69s. 6d. for No. 1, but business can be placed at fully 1s. per ton below these figures. On the North-West Coast prices remain unchanged, with Bessemer mixed numbers at 70s. per ton at works.

LANCASHIRE.—During the current week buying interest on the part of local users of pig-iron has been very moderate, and sellers' reports are unanimous as to the unsatisfactory conditions. As indicated below, there has been no appreciable alteration in prices, Derbyshire makers quoting for delivery equal to Manchester at from 68s. 6d. to 69s. 6d., or 70s. at the maximum, with Staffordshire at about the same level and Scottish at from 87s. to 88s., according to quantity.

THE MIDLANDS.—The Birmingham market for foundry pig continues slow, consumers restricting purchases to small lots sufficient to carry on from week to week. Derbyshire No. 3 is now quoted at 60s. per ton. Northamptonshire 55s. to 56s., and North Staffordshire 60s. at the furnaces.

SCOTLAND.—General holiday conditions prevailing in this area, it is only natural to expect that the Scotch pig-iron market should be exceedingly quiet. Any business appearing is only for trifling quantities, and the prospects at the moment are exceedingly depressing. Notwithstanding these adverse influences, there is no change in the price, which remains on the basis of 70s. for No. 3 foundry f.o.t. furnaces.

Finished Iron.

Throughout the Black Country and the adjacent districts the ironworks position does not seem to improve to any appreciable extent. A few orders have come through from stock merchants for crown iron, but prices remain very low in view of the keen competition between works in this area and those in Lancashire and Derbyshire. Crown iron prices continue to vary considerably, and are anything from £9 upwards, while nut and bolt iron is offered at £8 12s. 6d. to £8 15s. per ton. There is, however, little business being placed by local consumers for the latter, because, by force of competition, the bulk of the business goes abroad owing to the great disparity between the two figures. With regard to marked bars, the fixed figure is £12 at makers' works. The makers have been fairly well occupied up to just recently, but there has been a falling away of any specifications of note, and at the present moment they have anything but good order books.

Steel.

Business of late in the markets for steel materials has been irregular, but sufficient, it is stated, has been transacted of late with Continental works considerably to improve their position. It is doubtful, however, if new business is coming forward in sufficient quantities to take the place of the orders which have been worked off, and this accounts for a somewhat weaker tendency in the market. A' Sheffield acid billet demands have dropped rather sharply, but basic sales keep up fairly well. Wire rods are quiet. In the tinplate market the trade done during the week has been mainly on the basis of 18s. 4½d. to 18s. 6d. for prompt delivery, and 18s. 3d. for shipment ahead, net cash, f.o.b. Wales.

Scrap.

The existing stagnation in the iron and steel industries naturally induces a corresponding reduction of demands for scrap metal, and business in the principal markets is consequently inactive. In Scotland the market for cast-iron scrap continues slow, and it is difficult to get buyers interested even at low prices. Machinery cast-iron scrap suitable for foundries is at 67s. 6d., and heavy ordinary cast 62s. 6d. Old cast-iron railway chairs are being offered at 66s. to 67s. 6d. per ton, but with few buyers. Light cast-iron scrap is easy at 57s. 6d. per ton in each case, delivered f.o.t. consumers' works. At Middlesbrough, although there is only a limited demand for heavy cast iron, prices keep fairly steady, and ordinary quality has been sold at 61s. 6d., whereas the quoted figure for weeks past has been 62s. Machinery quality is unchanged at 66s.

Metals.

Copper.—The recent extremely limited range of fluctuations in warrant copper values, varying only to the extent of a shilling or so each week, offers convincing testimony to the consistent steadiness of markets. For this steadiness the continued high level of world consumption is, of course, largely responsible, it now being generally realised that the comparative slackness of current demand is the necessary sequel to exceptionally heavy buying during May and June, rather than an indication of any decrease in consumers' actual requirements.

Closing quotations are:—

Cash.—Thursday, £63 to £63 1s. 3d.; Friday, £62 15s. to £62 16s. 3d.; Monday, £62 15s. to £62 16s. 3d.; Tuesday, £62 17s. 6d. to £63; Wednesday, £63 1s. 3d. to £63 2s. 6d.

Three Months.—Thursday, £63 2s. 6d. to £63 3s. 9d.; Friday, £62 17s. 6d. to £62 18s. 9d.; Monday, £62 17s. 6d. to £63; Tuesday, £63 1s. 3d. to £63 2s. 6d.; Wednesday, £63 6s. 3d. to £63 7s. 6d.

Tin.—This section of the market has again developed the most sensational features of the past week's trading, closing on Friday with a total decline of nearly £8, an amount certainly not justified by the figures of the June statistics, which actually disclosed a considerable decrease in visible supplies. Later market views of the outlook are now not so despondent as they have been. It is becoming increasingly realised that, with a protracted depression at the current price, there must be a restriction on production, for those mines which cannot work at a profit with tin under £220 will have to cease operations.

Official closing prices:—

Cash.—Thursday, £206 to £206 2s. 6d.; Friday, £206 12s. 6d. to £206 17s. 6d.; Monday, £206 15s. to £206 17s. 6d.; Tuesday, £209 2s. 6d. to £209 5s.; Wednesday, £209 10s. to £209 15s.

Three Months.—Thursday, £203 12s. 6d. to £203 15s.; Friday, £204 5s. to £204 7s. 6d.; Monday, £204 7s. 6d. to £204 10s.; Tuesday, £206 12s. 6d. to £206 15s.; Wednesday, £206 10s. to £206 15s.

Spelter.—Reports of improved demand in the galvanishing trades have brought about more settled conditions in the spelter markets. Liquidation of stocks by some holders caused a slight temporary decline in values, but on the whole quotations have been firm, fluctuating only within very narrow limits. American advices indicate a further improvement in demand, with prices showing an upward tendency.

Daily quotations are:—

Ordinary. — Thursday, £25 8s. 9d.; Friday, £25 6s. 3d.; Monday, £25 3s. 9d.; Tuesday, £25 1s. 3d.; Wednesday, £25 2s. 6d.

Lead.—The demand for this metal, both at home and abroad, has been well maintained, having been of sufficient volume to absorb comparatively heavy arrivals, and the market is accordingly showing considerable firmness. Values have remained very steady, but if the conditions which have prevailed of late continue, an early rise seems inevitable. Such an appreciation is made all the more probable by the recent publication of production statistics, which show a reduction in world output during the first five months of the year of over 15,000 tons, as compared with the corresponding period of 1927.

Closing prices:—

Soft Foreign Prompt.—Thursday, £20 10s.; Friday, £20 7s. 6d.; Monday, £20 3s. 9d.; Tuesday, £20 2s. 6d.; Wednesday, £20 5s.

New Companies.

British Turbo Engines, Limited, 22, Church Street, Shaftesbury Avenue, London, W.1.—Capital £200.

Mather & Smith, Limited, Godinton Road, Ashford, Kent.—Capital £3,000. Iron and brass founders, etc. Director: D. G. J. W. Mather.

E. J. Farr & Company, Limited, The Triangle, Yeovil.—Capital £2,000. Scrap iron merchants, etc. Directors: E. P. Wheatley and J. P. Oliver.

Positive Lock Washer Company, Limited, 21, York Street, Glasgow.—Capital £10,000. Steel merchants, etc. Directors: J. T. MacFarlane, J. M. T. Tod and J. P. Murray.

Vidal Engineering Company, Limited, Thornton Road, Croydon.—Capital £20,000. Directors: A. S. Kettelwell, E. S. Richards, R. Waudby and A. Kettelwell.

Cuthbertson & Company, Limited, 217, West George Street, Glasgow.—Capital £2,000. Electrical and mechanical engineers, etc. Directors: R. T. Cuthbertson, W. M. Howitt and J. Lawrie.

Vickers (Crayford), Limited.—Capital £400,000 in £1 shares, to acquire from Vickers, Limited, and carry on and extend that part of its undertaking carried on at Crayford, and to carry on the business of mechanical, civil, electrical and general engineers, etc.

Vickers (Aviation), Limited.—Capital £250,000 in £1 shares, to acquire from Vickers, Limited, and carry on and extend that part of its undertaking carried on at Weybridge, and to carry on the business of manufacturers of and dealers in airships and aircraft of all kinds, etc.

June Tin Statistics.

SUPPLIES.—Straits shipments, 8,516 tons; Australian shipments, 111 tons; Banka and Billiton shipments, 806 tons; Chinese shipments, 10 tons; standard arrivals in U.K. and U.S.A., 932 tons.

DELIVERIES.—U.K., 1,691 tons; U.S.A., 6,950 tons; Continent, 1,778 tons; other countries, 789 tons.

TOTAL VISIBLE SUPPLY.—Month's shipments, 9,443 tons; other afloat, 2,484 tons; total afloat, 11,791 tons; landing, 1,919 tons; in warehouse, 2,385 tons; total stocks, 4,304 tons. Total visible supply, 16,231 tons.

UNITED KINGDOM.—Afloat from Straits, 840 tons; from Australia, 46 tons; from Batavia, 42 tons; and from China, nil. Landing (Straits and Australian), 180 tons; landing (other), 209. Stocks of Straits and Australian, 1,078 tons; Banka and/or Billiton, 78 tons; and other standard, 611 tons. Total visible supply, 3,084 tons.

UNITED STATES OF AMERICA.—Afloat (all kinds), 6,903 tons; stocks and landing, 2,148 tons.

CONTINENT, ETC.—Straits afloat, 3,191 tons; Banka and Billiton afloat, 905 tons; stocks in Holland, nil. Total visible supply, 16,231 tons.

ARRIVALS of Bolivian tin ore, etc., in terms of fine tin, 2,877 tons; Nigerian, 590 tons.

Applications for Trade Marks.

The following applications to register trade marks are extracted from the "Trade Marks Journal":—

"NONCROSALOY."—Aluminium alloys. Henry James Garrard, 14 to 16, Chandos House, Palmer Street, London, S.W.1.

"PRIMA CORONA."—Galvanised and corrugated iron and steel sheets. Brown & Tawse, Limited, 49, Meadowside, Dundee.

HURRICANE LAMP (DESIGN).—Galvanised iron and steel sheets. The Anglo-Siam Corporation, Limited, 5 and 7, St. Helen's Place, Bishopsgate, London, E.C.3.

THE PARTNERSHIP between Messrs. W. J. Morgan, W. J. Patience, and H. D. Davis, carrying on business at 38c, Peterborough Road, London, S.W.6, under the style of the Star Welding Company, has been dissolved.

Sterling

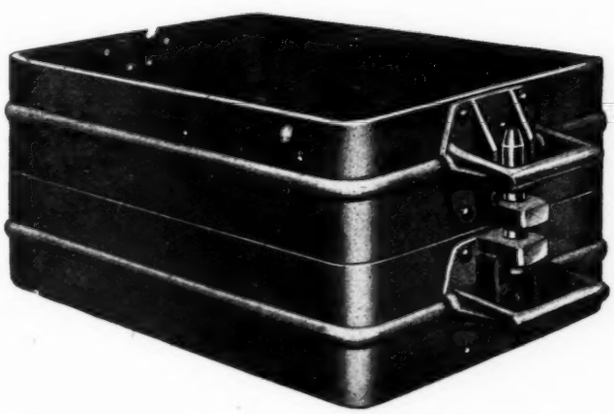
SOLID RIBBED ROLLED STEEL

MOULDING BOXES

are recognised as Standard Box equipment by the majority of the leading foundries and engineering establishments in this country and overseas.

Because they speed up production, save unnecessary labour, produce accurate castings and make for all-round efficiency.

If you are not a user of Sterling Boxes your competitors have the advantage of you.



STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1.

BEDFORD.

Telephone : 3345 BEDFORD.
Telegrams : "STERFLASK, BEDFORD."
Code .WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	63	1	3
Three months ..	63	6	3
Electrolytic	68	10	0
Tough	65	15	0
Best selected ..	65	10	0
Sheets	94	0	0
India	76	10	0
Wire bars	69	0	0
Do. July ..	69	0	0
Do. August ..	69	0	0
Ingot bars	69	0	0
H.C. Wire rods ..	73	5	0
Off. av. cash, June ..	63	13	11½
Do. 3 mths., June ..	63	14	0½
Do., Sttlmnt., June	63	14	0½
Do., Electro, June ..	68	19	0½
Do., B.S., June ..	67	5	10
Aver. spot price, copper, June	63	13	11½
Do., Wire bars, June	69	3	4
Solid drawn tubes			13½d.
Brazed tubes			13½d.
Wire			10d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld. ..	7½d.
Sheets to 10 w.g. ..	10½d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares ..	8d.
Do. 4 × 3 Sheets ..	8½d.

TIN.

		£	s.	d.
Standard cash ..		209	10	0
Three months ..		206	10	0
English		208	0	0
Bars		209	0	0
Straits ..	(Nom.)	212	2	6
Australian ..	(Nom.)	211	12	6
Eastern		209	5	0
Banca	(Nom.)	213	2	6
Off. av. cash, June ..		217	17	5½
Do., 3 mths., June		215	9	3½
Do., Sttlmt., June		217	7	0½
Aver. spot, June ..		217	7	5½

SPELTER.

	£	s.	d.
Ordinary	25	2	6
Remelted	23	17	6
Hard	20	2	6
Electro 99.9	29	2	6
English	25	7	6
India	21	2	6
Zinc dust	33	0	0
Zinc ashes	8	0	0
Off. aver., June ..	25	10	11½
Aver., spot, June ..	25	13	3½

LEAD.

	£	s.	d.
Soft foreign ppt. ..	20	5	0
English	21	15	0
Off. average, June ..	21	1	11½
Average spot, June ..	20	19	8½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	33	15	0
Do. V.M. ex whf.	32	5	0
Rods	39	0	0
Boiler plates	29	10	0
Battery plates ..	31	5	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	59	10	0
Chinese	39	10	0
Crude	33	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	21	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	8	0	0
45/50%	12	15	0
75%	20	0	0
Ferro-vanadium—			
35/40%	14/3 lb. Va.		
Ferro-molybdenum—			
70/75% c. free ..	4/6 lb. Mo.		
Ferro-titanium—			
23/25% carbonless ..	1/2 lb.		
Ferro-phosphorus, 20/25%	£18	0	0
Ferro-tungsten—			
80/85%, c. fr.	1/3½lb.		
Tungsten metal powder—			
98/99%	1/7½ lb.		
Ferro-chrome—			
2/4% car.	£32	0	0
4/6% car.	£22	0	0
6/8% car.	£21	12	6
8/10% car.	£21	0	0
Ferro-chrome—			
Max. 2% car.	£33	15	0
Max. 1% car.	£39	0	0
Max. 0.70% car.	£44	17	6
70% carbonless	1/2 lb.		
Nickel—99% cubes or pellets	£175	0	0
Ferro-cobalt	9/- lb.		
Aluminium 98/99% ..	£105	0	0
Metallic chromium—			
96/98%	2/8 lb.		
Ferro-manganese (net)—			
76/80%, loose	£13	10	0
76/80%, packed	£14	10	0
76/80%, export	£13	5	0
Metallic manganese—			
94/96%, carbonless ..	1/6 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0	2	3
Finished bars, 18% tungsten	£0	2	9

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over .. .. .. 4d. lb.
Rounds and squares, under ½ in. to ¼ in. .. .. 3d. lb.
Do., under ¼ in. to ⅛ in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in. .. .. 3d. lb.
Do., under ¼ in. × ¼ in. .. 1/- lb.
Bevels of approved sizes and sections .. .. 6d. lb.
Bars cut to length, 10% extra.

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel	3	7	6			
Bundled steel and shrngs. ..	3	2	6	to 3	5	0
Mixed iron and steel ..	3	0	0	to 3	2	6
Heavy cast iron	3	0	0			
Good machinery for foundries	3	2	6			
Cleveland—						
Heavy steel	2	15	0			
Steel turnings	2	8	6			
Cast iron borings ..	2	3	0			
Heavy forge	3	10	0			
Bushelled scrap	3	2	6			
Cast-iron scrap	3	1	6	to 3	6	0
Lancashire—						
Cast-iron scrap	3	0	0			
Hvy. wrought	2	17	6			
Steel turnings	2	2	6			

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	52	0	0
Brass	38	0	0
Lead (less usual draft) ..	18	0	0
Tea lead	16	0	0
Zinc	16	10	0
New aluminium cuttings..	70	0	0
Braziery copper	48	0	0
Gunmetal	49	0	0
Hollow pewter	155	0	0
Shaped black pewter ..	110	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	69/6
Hematite M/Nos.	69/-
N.W. Coast—	
Hem. M/Nos. d/d Glas. ..	79/-
,, d/d Birm.	86/-
Midlands—	
Staffs. common*	67/6
,, No. 4 forge ..	57/-
,, No. 3 fdry... ..	60/-
Shrops. basic	—
,, Cold blast, ord.* ..	—
,, ,, roll iron* ..	—
* d/d Birmingham.	
Northants forge	52/6
,, fdry. No. 3 ..	55/6
Derbyshire forge	59/-
,, fdry. No. 3 ..	61/6
,, basic	61/-
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	62/6
,, fdry. No. 3 ..	64/6
Lincs. forge	63/6
,, fdry. No. 3 ..	64/6
E.C. hematite	81/6
W.C. hematite	84/-
Lincs. (at furnaces)—	
Forge No. 4	59/-
Foundry No. 3	60/-
Basic	61/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3 ..	69/-
Northants foundry No. 3..	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3 ..	87/6
Glengarnock, No. 3 ..	87/6
Gartsherrie, No. 3 ..	87/6
Monkland, No. 3 ..	87/6
Shotts, No. 3	87/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.) nom.	9	10	0	to 10	15	0
Nut and bolt iron	8	12	6	to 8	15	0
Hoops		11	10	0		
Marked bars (Staffs.) f.o.t.		12	0	0		
Gas strip		11	10	0		
Bolts and nuts, ¾ in. × ¾ in.		15	5	0		
Steel—						
Ship plates..		8	7	6		
Boiler plts...		10	10	0		
Chequer plts.		10	12	6		
Angles		7	17	6		
Tees		8	17	6		
Joists		7	17	6		
Rounds and squares, 3 in. to 5½ in.		8	17	6		
Rounds under 3 in. to ¾ in. (Untested)		7	15	0 and upwards		
Flats, over 5 in. wide and up		8	7	6		
Flats, 5 in. to 1½ in.		7	17	6		
Rails, heavy		8	10	0		
Fishplates		12	10	0		
Hoops (Staffs.)		10	0	0		
Black sheets, 24g. ..		9	17	6		
Galv. cor. shts., 24g. ..		13	7	6		
Galv. fencing wire 8g. plain		12	10	0		
Billets, soft	6	2	6	to 6	15	0
Billets, hard	7	2	6	to 7	12	6
Sheet bars ..	6	0	0	to 6	2	6
Tin bars ..	6	0	0	to 6	2	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 3½
Rods	1 3
Tubes	1 8½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising ..	9d. to 1/3
Rolled—	
To 9 in. wide ..	1/3 to 1/9
To 12 in. wide ..	1/3½ to 1/9½
To 15 in. wide ..	1/3½ to 1/9½
To 18 in. wide ..	1/4 to 1/10
To 21 in. wide ..	1/4½ to 1/10½
To 25 in. wide ..	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila. ..	20.76
No. 2 foundry, Valley	16.75
No. 2 foundry, Birm.	15.50
Basic	17.51
Bessemer	18.76
Malleable	18.76
Grey forge	18.01
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	32.00
O.-h. billets	32.00
O.-h. sheet bars	33.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.65
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd., 9 and 10 .	2.00
Wire nails	2.55
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplates, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	14/6 to 15/6
,, furnace	14/- to 14/3
Other Districts, foundry ..	—
,, ,, furnace (basis) ..	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes ..	20×14	box ..	18/6
,, ..	28×20	,, ..	37/-
,, ..	20×10	,, ..	27/3
,, ..	18½×14	,, ..	19/-
C.W. ..	20×14	,, ..	17/-
,, ..	28×20	,, ..	34/-
,, ..	20×10	,, ..	22/-
,, ..	18½×14	,, ..	15/9
Terneplates ..	28×20		34/- per box basis f.o.b.

SWEDISH IRON.

Bars, hammered,	£17 10 0 to £18 10 0
Rolled Ord.	..£15 0 0 to £15 10 0
Nail rods	.. £15 7 6 to £15 15 0
Keg. steel nom. ..	£33 to £35
Faggot steel nom.	to £25
Blooms, according to quality	to £12
Pig-iron ..	£5 15 0 to £6 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
July 5	63 0 0	dec. 2/6
,, 6	62 15 0	,, 5/-
,, 9	62 15 0	No change
,, 10	62 17 6	inc. 2/6
,, 11	63 1 3	,, 3/9

Electrolytic Copper.

	£ s. d.	
July 5	68 10 0	No change
,, 6	68 10 0	,, ,,
,, 9	68 10 0	,, ,,
,, 10	68 10 0	,, ,,
,, 11	68 10 0	,, ,,

Standard Tin (cash).

	£ s. d.	
July 5	206 0 0	dec. 12/6
,, 6	206 12 6	inc. 12/6
,, 9	206 15 0	,, 2/6
,, 10	209 2 6	,, 47/6
,, 11	209 10 0	,, 7/6

Tin (English ingots).

	£ s. d.	
July 5	204 0 0	dec. 20/-
,, 6	204 15 0	inc. 15/-
,, 9	204 15 0	No change
,, 10	207 0 0	inc. 45/-
,, 11	208 0 0	,, 20/-

Zinc Sheets (English)

	£ s. d.	
July 5	33 15 0	No change
,, 6	33 15 0	,, ,,
,, 9	33 15 0	,, ,,
,, 10	33 15 0	,, ,,
,, 11	33 15 0	,, ,,

Spelter (ordinary).

	£ s. d.	
July 5	25 8 9	No change
,, 6	25 6 3	dec. 2/6
,, 9	25 3 9	,, 2/6
,, 10	25 1 3	,, 2/6
,, 11	25 2 6	inc. 1/3

Lead (English).

	£ s. d.	
July 5	22 0 0	No change
,, 6	22 0 0	,, ,,
,, 9	21 15 0	dec. 5/-
,, 10	21 15 0	No change
,, 11	21 15 0	,, ,,

AVERAGE PRICES OF STEEL RAILS.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	£ s. d	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1908 ..	6 2 6	6 0 0	6 0 0	5 15 6	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 10 0	5 16 3
1909 ..	5 5 0	5 5 0	5 5 0	5 0 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0
1910 ..	5 5 0	5 7 6	5 7 6	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 8 11½
1911 ..	5 15 0	5 15 0	5 15 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 13 1½
1912 ..	5 13 1	5 15 0	5 15 0	5 15 7	6 1 6	6 6 3	6 7 6	6 8 0	6 11 3	6 12 6	6 12 6	6 13 9	6 4 4
1913 ..	6 15 0	6 14 4½	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 10 0	6 10 0	6 10 0	6 10 0	6 12 0
1914 ..	6 10 0	6 10 0	6 6 3	6 0 0	6 0 0	6 0 0	5 14 0	6 2 6	6 13 9	6 12 0	6 7 6	6 7 6	6 5 3½
1915 ..	6 10 6	6 17 6	7 5 0	7 12 6	7 12 6	7 17 6	8 17 6	9 2 6	9 2 6	9 2 6	9 7 6	10 10 6	8 6 6½
1916 ..	10 19 4	11 0 0	11 0 0	10 18 9	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 9 10
1917 ..	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1918 ..	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1919 ..	10 17 6	13 7 6	13 7 6	13 7 6	15 0 0	15 10 0	16 0 0	16 10 0	16 10 0	16 10 0	16 10 0	17 5 0	14 12 11
1920 ..	18 15 0	19 5 0	20 7 6	22 0 0	23 0 0	23 0 0	24 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	22 18 11½
1921 ..	23 5 0	20 4 0	18 0 0	17 0 0	15 0 0	15 0 0	14 0 0	14 0 0	14 0 0	11 12 6	10 10 0	10 0 0	15 4 3
1922 ..	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 0 0	8 15 0	8 15 0	8 15 0	8 15 0	9 4 2
1923 ..	8 17 6	9 2 0	10 5 0	10 10 0	10 10 0	10 10 0	9 15 0	9 0 0	8 15 0	8 15 0	8 19 0	9 5 0	9 9 10
1924 ..	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 2 6	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 2 3½
1925 ..	9 0 0	9 0 0	9 0 0	9 0 0	8 15 0	8 10 7½	8 10 0	8 10 0	8 10 0	8 4 0	8 0 0	8 0 0	8 11 7½
1926 ..	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11½
1927 ..	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 3 0	8 5 0	8 5 0	8 4 10
1928 ..	8 5 0	8 5 0	8 5 9	8 6 3	8 6 3	—	—	—	—	—	—	—	—

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Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1915 ..	83 11	88 6	94 8	107 0	102 6	101 3	98 9	98 7½	96 6	104 0	124 1	130 0	106 11½
1916 ..	133 9	140 0	136 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	128 1½
1917 ..	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1918 ..	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1919 ..	122 6	122 6	122 6	122 6	179 2	190 0	197 6	200 0	200 0	200 0	200 0	200 0	171 4
1920 ..	220 0	220 0	240 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	251 8
1921 ..	240 0	220 0	180 0	180 0	180 0	160 0	160 0	160 0	137 0	127 6	117 6	104 6	162 2
1922 ..	97 6	91 7½	100 0	98 6	97 1½	94 7	93 6	90 9	89 7	91 10½	93 0	93 2	94 5½
1923 ..	94 6	104 9	122 0	126 10½	122 0	115 3	107 0	98 8½	98 10½	99 1½	100 6½	102 3	107 10½
1924 ..	102 4½	101 3	99 7½	99 0	98 9½	97 4½	95 3½	93 1½	90 7½	88 0	88 4½	88 6	95 2½
1925 ..	87 5	85 9	84 7½	82 6	80 10½	79 3	77 1½	75 7½	75 0	74 3½	74 9	76 0	79 5½
1926 ..	77 3	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 5½	81 7½
1927 ..	90 0	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	75 0	72 9	71 9	71 1½	79 2½
1928 ..	69 7½	69 7½	69 9	70 0	70 0	69 3	—	—	—	—	—	—	—

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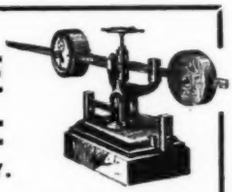

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